The Welding Engineer

Edited by L. B. Mackenzie

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AIRCO
DAVIS BOURNONVILLE

ANYTHING AND EVERYTHING
FOR OXYACETYLENE WELDING AND CUTTING

Airco-D-B No. 1A Oxygraph for cutting steel plates and forging to any shape

Thousands of problems of production have been met by oxyacetylene hand torches. As many more are being met by mechanical welding and cutting equipment. Airco engineers will gladly point the way.

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Manufacturer of Airco Oxygen—Airco Acetylene—Airco-Davis-Bournonville Welding and Cutting Apparatus and Supplies, Acetylene Generators and Specially Designed Machines for Automatic Welding and Cutting—Nitrogen, Argon and other Airco Atmospheric Gas Products

Controls the manufacture and sale of National Carbide

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Airco District Offices, Plants and Distributing Stations conveniently located throughout the country.
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"Airco Oxygen and Acetylene Service is Good Service"

Published monthly by the Welding Engineer Publishing Co. Entered as second class matter Jan. 20, 1916, at the Post Office at Chicago, Ill. Under the Act of March 3, 1879.

Reducing 12 hours to 40 minutes

This big *cast iron* punch press frame weighs 2800 pounds.

One leg, measuring 9 inches square in cross section, was cracked clear through.

In order to weld it, chamfers 3½" wide and 4½" deep, on either side were necessary.

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The Oxweld Blowpipe did it in 40 minutes!

And the work was not only done in 1/18th the time commonly required but was done well, the sides were even and clean.

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Oxweld

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Unequalled in construction
Unsurpassed in performance

Balance

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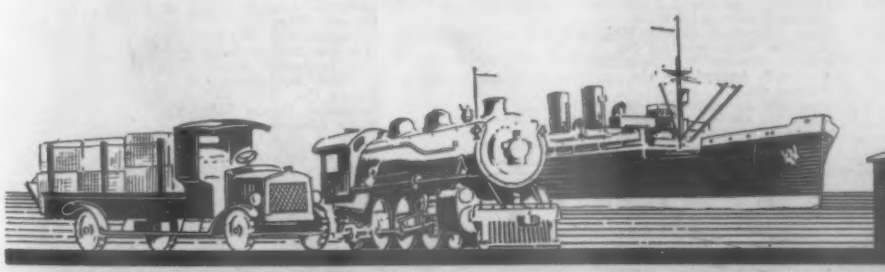

WELDING PUROX CUTTING

Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

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See "Torches"

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High grade welding equipment would be of little value without the use of pure welding metal.

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Page-Armco Electrodes conform to the American Welding Society Specifications for Electrodes, Grade E-No. 1-A.

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Modern Engineering Co.
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Imperial Brass Mfg. Co.
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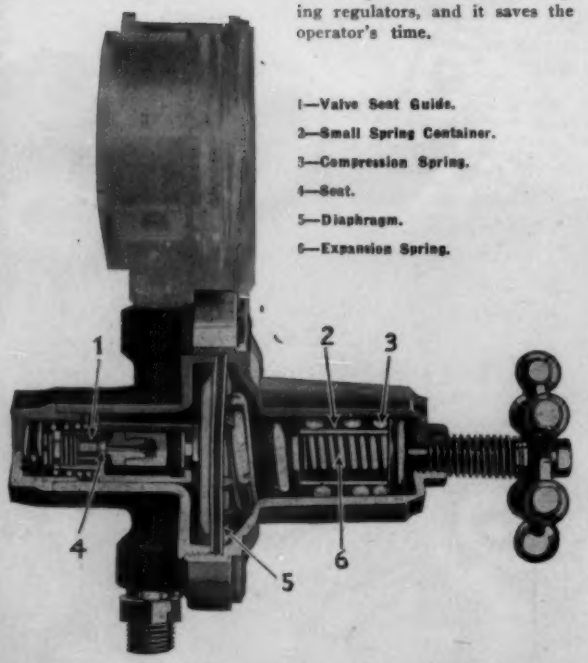

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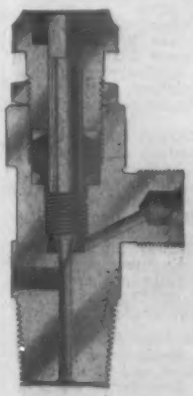

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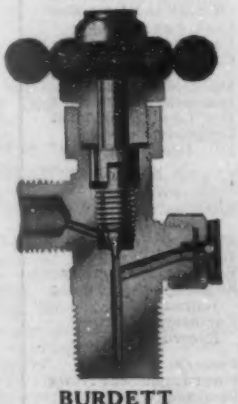

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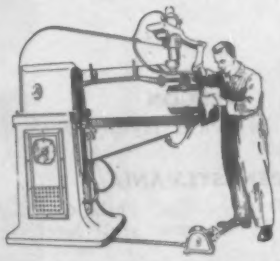

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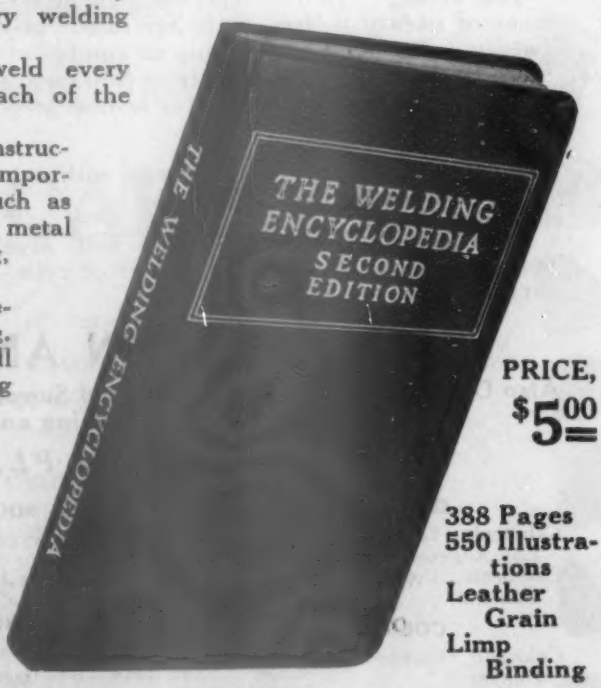

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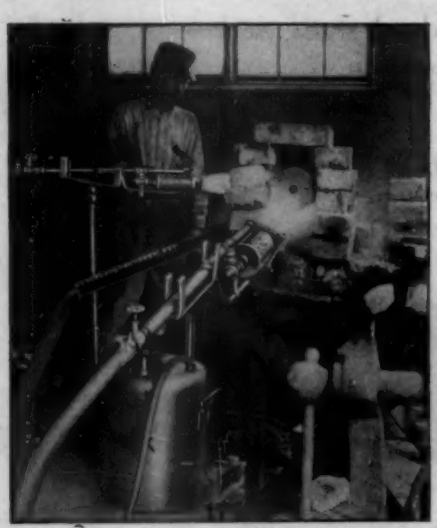

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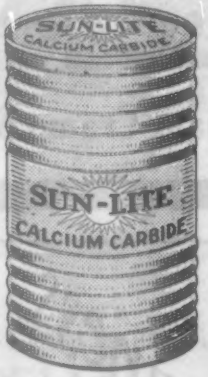

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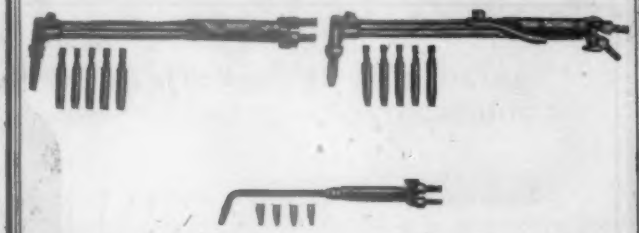

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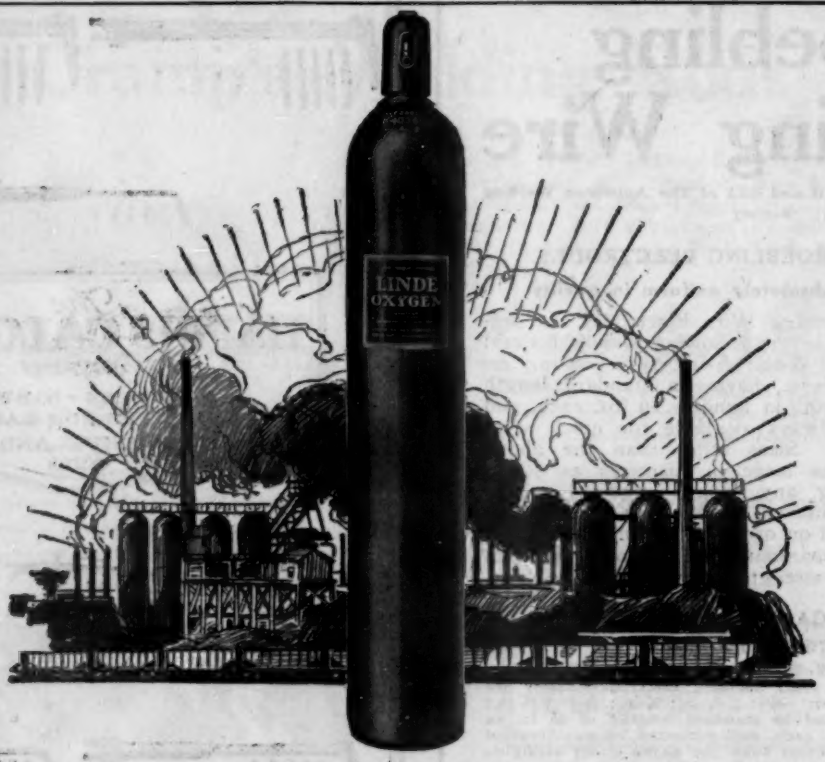

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LINDE OXYGEN

ARC WELDING PROGRESS*

Mechanical and Chemical Properties of Arc Welds—Improving the Deposit—Producing Sound Welds—Testing—Applications

By P. P. Pipes†

THE use of electrical energy for welding, in the metal working trades, passed from the experimental to the practical stage many years ago, yet the subject is quite vague in the minds of many mechanics and engineers. Many products are being manufactured today by riveting and various other methods which could be manufactured by the use of electric welding at a greatly reduced cost.

Arc Welding

The "Electric Arc" welding process appears to have been first used in 1881, by Meritens for welding together of lead plates of storage batteries, using a carbon arc. Since that time, several systems have been developed, yet the two most generally used today are the Slavianoff or "metallic-arc" process and the Bernardos or "carbon-arc" process. The temperature of the electric arc depends upon the temperature at which vaporization occurs for the particular kind of electrode used. For instance, copper vaporizes at twenty-one hundred degrees centigrade, iron at 2,450 degrees C, nickel at 2,450 degrees C, and carbon at 3,600 degrees C. It naturally follows then that the amount of carbon in metallic electrodes influences the arc temperature.

Metallic Arc Welding

In the direct current metallic arc, there is a difference in the amount of heat liberated in the anode "positive" and cathode "negative" zones depending on the analysis of the electrodes used. A simple experiment was performed recently by the writer to determine this ratio of heat distribution. It was assumed that by holding an arc between two electrodes of the same diameter and composition, in a straight line and horizontal plane, that the amount of burn-offon the positive and negative electrodes was directly proportional to the amount of heat liberated in the anode and cothode zones respectively. The current density in all the electrodes was maintained approximately constant at ten thousand amperes per square inch cross section.

KIND OF ELECTRODE	AMOUNT OF BURN OFF			
	Positive Electrode		Negative Electrode	
	Inches	% Total	Inches	% Total
A 5/32" Steel (c-0.15)	3.50	54	2.94	46
B 3/16" " (c-0.10)	3.81	57	2.88	43
C 1/8" " (c- low)	5.06	57	3.81	43
D 1/8" " (c- low)	4.50	59	3.13	41
E 3/32" " (c-0.60)	3.75	48	4.13	52
F 5/32" " (c-0.12)*	4.00	58	2.94	42
G 5/32" " (c- dow)*	4.69	60	3.13	40
H 5/32" " (Quasi-Arc)	3.50	47	3.88	53
I 1/8" Monel Metal*	4.25	44	5.32	56
J 1/4" Cast Iron (c-3.5)	3.13	44	4.00	56

c=Carbon content of electrodes in per cent.
*=Electrodes were coated.

The table given herewith is not accurate by any means, as only a few electrodes were tested, yet the results prove that with an increase of carbon content in the steel electrodes, there is an increase in the percentage of heat liberated in the cathode zone accompanied by a decrease in the anode zone. For iron and mild steel electrodes, the anode zone liberates a greater amount of heat, although when the carbon content exceeds one half per cent, it is seen that the cathode zone liberates the greater amount of heat. It is believed that a thorough investigation of this phenomenon would result in a better understanding of arc characteristics and the correct procedure in applying the process.

Mechanical & Chemical Properties

In applying the metallic arc process, it is important to consider the character of the metal deposited as regards the mechanical and chemical properties. The conditions under which a metallic arc weld is made cause it to have a mechanical structure similar to an inferior steel casting. With the proper electrodes, it is possible to make the deposit hard or soft, high or low in tensile strength, but the coefficient of elasticity always remains small and the modulus of elasticity remains about the same for the deposited metal as for rolled stock of similar composition.

The ultimate tensil strength of properly made flush butt welded joints runs around ninety to ninety-five per cent of standard rolled stock and by reinforcing the welded joint with additional metal, more than 100% strength can be obtained in the weld as compared to the rolled plate. F. B. Webster, Naval Architect, reported a series of tests as made on treble riveted lap joints,—full filet arc welded lap joints, both edges,—and arc welded butt joints with following results:

Thickness	Kind	Efficiency
0.53"	Treble riveted lap joints	62.5%
0.514"	Lap weld—full fillet—both edges	71.0%
0.505"	Butt weld—not strapped	96.0%

On a series of tests for alternating stresses, it was found that full fillet lap welded both edges and treble lap riveted joints would endure about 60% of the number of alternation of a similar plain plate while a butt welded joint would withstand about 70%.

The ultimate shearing strength of arc deposited metals is considerably lower than the tensil strength. On a series of tests, the writer obtained the following results:

Bar size	Amount of lap	Size electrode	Ultimate shearing strength
2" x 1/2" to 3" x 1/2"	3.5"	3/16"	35,300 No./sq. in
5/8" x 5/8" to 1-3/4" x 1/2"	2"	3/16"	30,000

These results are slightly lower than might be expected, for in most all cases, parts of the parent metal pulled out as a result of the welds being made parallel with the grain or fibre of the steel bars. In the fabrication of structural shapes, it is quite evident that diamond shaped plates are far better than rectangular plates since a greater shearing strength per square inch can be developed and the plate area can be reduced over 50%.

Micro-Structure

A microscopic analysis of arc deposited metal reveals a considerable number of cavities and oxide inclusions which occur indiscriminently throughout the crystals of iron. This unsoundness may be avoided to some extent if extreme precaution is taken during fusion, however, it is impossible to eliminate entirely these imperfections. The oxidation takes place when the oxygen of the air combines with the iron forming iron oxide, and theoretically it would seem that with small electrodes and small currents, there would be more oxidation proportionately than with large electrodes and large currents since the amount of oxidation should depend upon the ratio of area to volume of arc stream, and the area increases only as the diameter, whereas the volume of arc stream increases as the square the diameter. This, however, does not hold true, as welds made with 1/8" electrodes do not seem to contain any more oxide inclusions than welds made with 5/32" or 3/16" electrodes.

Another very characteristic feature of arc fused metal as

Paper read before April meeting of American Society of Mechnical Engineers, Hartford, Conn., Section.

†Engineer, Welding Dept., Lincoln Electric Co.

found by the Bureau of Standards' investigation, is the presence of numerous "needles" or "plates" due to nitrogen being taken up by the iron during the fusion. Pure iron which has been nitrogonized gives the same appearance and is similar in behavior to arc fused metal upon heating. It is interesting to note the large increase in the nitrogen content, which is approximately 0.13% for either pure iron or mild steel electrodes. This high nitrogen content would be regarded as very undesirable in ordinary steel, yet it does not apparently seem to influence the mechanical properties of arc fused metal. The other inperfections far overshadow any possible defect of the nitrogen content. The use of coated electrodes does not apparently affect the amount of increase in the nitrogen content of arc fused metal. Another interesting feature to note is that the carbon content of arc fused metal is about the same when either iron or mild steel electrodes are used, this amount being about 0.02%. The chemical analysis of arc fused metal as compared to that of steel electrodes used, show that the carbon, silicon, and manganese content are almost oxidized away during the welding process, while the sulphur and phosphorus content remains about the same. Manganese being a good deoxidizing agent, is helpful in decreasing the oxidation which takes place and is therefore, a valuable constitutent in mild steel electrodes. Sulphur and phosphorus should be kept as low as possible as these are harmful elements.

Improving Deposited Metal

The Bureau of Standards made some exhaustive heat treatment tests of arc welds which consisted mainly of quenching the specimen in cold water after heating for a period of ten to fifteen minutes at a temperature of 925 degrees to 1,000 degrees C. The specimens were then tempered at different temperatures ranging from 650 degrees to 925 degrees C, for periods of ten to twenty minutes. This heat treatment apparently eliminates about 50% of the nitrogen content, however, as stated previously, the nitrogen content has very little influence on the ultimate tensil strength of the welded joint.

By giving more arc fused metal, a heat and mechanical treatment, E. H. Escholtz found it was possible to improve the tensil strength and also enable the weld to withstand fatigue and vibrating stresses. On one particular sample of chrome-vanadium steel which was heated and forged after welding, he obtained a tensil strength of 132,000 lbs. per square inch with a reduction in area of 5.6%. This heat and forge treatment does not seem practical, yet when we consider the various uses to which we find the hammer-gas process applied today, there are probably many welded jobs which could be given this treatment. The main objection would be the great additional expense for equipment, time, etc.

The carbon arc is used extensively in the steel foundries for cutting off risers, building up surfaces, and filling in holes, etc. Where used for cutting, the arc actually melts the metal away, so it is necessary to make the width of the cut slightly greater than the size of the electrode. The smoothness of the cut depends largely upon the skill of the operator, however, because the arc has a tendency to jump from one point to another, it is not possible to make as smooth a cut as is made with the oxy-acetylene torch. Usually 300 to 1,000 amperes are used in cutting, depending on the thickness of metal to be cut. The speed of cutting will range from one-third to three-quarters of a square inch cross section per minute per hundred amperes in the arc, depending on the amount of arc current and thickness of plate. With a reasonable power rate, the cost of cutting with the electric arc is lower than the cost of cutting by means of the gas torch.

Up until about one year ago, the carbon arc was operated entirely by hand and was applicable only to heavy steel castings, forgings, cutting off risers, etc. During the past year, the Lincoln Electric Company has developed and put on the market an automatic carbon arc welding machine for the longitudinal and circumferential seams of tanks, range boilers, steel cases, steel barrels and similar classes of production sheet metal welding. Since the carbon arc produces a higher temperature than the metallic arc, with the proper control, very great speeds of welding can be obtained. For instance, on ¼" plate butt reinforced weld, a speed of 35 feet per hour is easily obtained, while on 14, 16 and 18 gauges, speeds of 100, 110 and 140 feet per hour respectively, can be obtained. On full fillet single weld lap joints on ¼", 12, 14, 16 and 18 gauges, speeds of 45, 100, 120, 150 and 175 feet per hour can be obtained. On flange welding, i.e., where the two edges are turned up and melted together without using any filler material on 12, 14, 16 and 18 gauges, speeds of 125, 150, 180 and 200 feet per hour can be obtained. In the case of butt welds, the welding wire is placed along the seams before welding and the carbon arc passing over, fuses both the wire and the base metal. In the case of lap, flange, or corner welding, no welding wire is used, as the base metal is merely fused together.

The microstructures of carbon arc welds show a more homogenuous metal and a less number of oxide inclusions than are found in metallic arc welds, which results in a higher tensil strength. Mechanical tests also show a marked increase in ductility, accompanied with a larger coefficient of elasticity. The following is the result of tensil tests made on ¼" plates butt welded with the carbon arc:

Size	Yield point	Reduction in area	Elongation	Ultimate tensil strength
4.15 x 0.252	37,760 No./sq. in.	52.7%	24.3%	57220 No./sq. in.

With a great increase in the speed of welding, with the improvement in the mechanical and chemical qualities of the welded joint, and with the elimination of the human element of personal skill, it is apparent that this method of welding, for production jobs where a large number of pieces of the same character are to be produced, is much superior to the hand metallic process. Great developments in welding can be expected in the near future in the manufacturing industry as welding costs are cut to a very low value with this process.

Production of Sound Welds

In the electric arc welding industry today, we are confronted with one very serious problem, that of obtaining a sufficient number of operators who can be relied upon to produce uniformly sound welds. Of course in any welding enterprise of magnitude, it is necessary to have a competent engineer at the head who is thoroughly familiar with design of welded joints and up to date welding practices. Under him should be a practical foreman, who has a thorough knowledge of the process as applied to the particular work at hand and a sufficient experience in actual welding practices.

The production of sound welds depends upon many things, such as design of joint, quality of metal to be welded, quality of welding wire, welding equipment, and characteristics of the operator. The last item is undoubtedly the most important of all, so in choosing men to do welding work, we should note that they have some sense of responsibility for "safety first," that they have the necessary mental and physical qualifications, that they have ingenuity and resourcefulness, and last but not least, that they take a pride in their work and always have that conscience in their job that spurs them on to greater efforts.

Tests for Welds

Tests for arc welded joints can be divided into two groups, namely,—destructive and non-destructive. Of course, with a destructive test such as applying a hydraulic pressure to a welded tank or pulling a welded bar in a tension machine, it is possible to determine exactly the mechanical properties of a welded joint, yet the test ruins the specimen for any useful purpose. If the variables entering into the making of a sound weld as previously stated, could be controlled within a narrow range, all of which can be with the exception of the operator, then the destructive method for testing would be quite satisfactory.

Many methods of non-destructive tests have been proposed from time to time, yet none seem to determine to any degree of accuracy what might be expected of a welded joint. The "magnetic reluctance" tests consists of applying a certain magneto-motive force between two points of the weld and noting the number of lines of force set up in the welded metal or in other

words, measuring the reluctance of the welded metal. The "electrical resistance" test consists of applying an electromotive force across the weld and measuring the current flow therein, which determines the resistance of the metal. A greater resistance or reluctance signifies a greater number of imperfections in the weld. Either of these two tests determines to some extent the quality of the welded metal, yet great difficulties are experienced in making the test and getting satisfactory results. It is stated that the combination of the two methods will determine to within the order of 10,000 lbs. per square inch, the tensil strength of a welded joint, which of course, would be satisfactory for most work. A test with air pressure or kerosene of course, would determine if the weld was porous, however, it would indicate very little regarding the tensil strength.

Metals That Can Be Welded

Electric arc welding has been used quite satisfactorily on various kinds of metals such as brass, bronze, copper, nickel, monel metal. cast iron, etc., however, the application to mild steel and iron products comprises perhaps over 90% of total arc welding applications.

In the welding of brass, bronze or copper, the use of phosphor bronze electrode with reversed polarity works out very satisfactory. Also the carbon arc is used in a great number of cases for welding these metals.

Monel metal, which is composed of about 65% nickel, 30% copper and 5% of other elements, can best be welded using monel metal electrodes coated with some deoxidizing agent. Considerable research work was carried on by the International Nickel Company in this field and a coating was developed that works very satisfactorily for the arc welding of monel metal. This coating consists principally of Manganese, Magnesium and Silicon in the proper proportions, mixed with either shellac or sodium silicate for a binder. In using this electrode, the work should be made negative and the rod positive and only one layer of metal used. Welds of monel metal when properly made, show a very high ductility and high tensil strength. Some test samples showed ultimate tensil strength of 47,000 lbs. per square inch with an elongation of 9.7%.

There is considerable controversy among experienced men in the welding field as to the welding of cast iron with the electric arc since some claim much greater limitations than others. Both the carbon and metallic arc processes are used, depending on the size and conditions under which a piece must be welded. Where it is possible to pre-heat a casting and weld with a carbon arc using a cast iron filler rod, a very good weld is obtained on average grade of cast iron. In most cases, it is necessary to weld the casting cold so the metallic arc process is used, and either steel, monel metal, nickel, or phosphor bronze electrodes are used. Using a steel welding rod makes a very hard deposit at the point of fusion between the cast iron and the added metal, as the free carbon of the iron combines with the steel, making high carbon steel. By using phosphor bronze, monel metal or nickel electrodes, this hard metal can be eliminated and fairly strong welds can be made. In the latter case, the electrodes should be coated with a deoxidizing agent and a reverse polarity used (welding rod positive). In making cast iron welds for strength and tightness, such as the welding of cylinders for steam engines, air compressors, etc., the usual procedure is to bevel the edges to be welded for a total angle of 90 degrees, then drill holes, tap and screw in steel studs irregularly over the bevelled surfaces. Beads of steel are then welded around each stud and finally the whole vee filled in with a successive number of layers in such a manner that the least amount of contraction takes place in the weld.

Applications

The largest commercial use of arc welding was perhaps first made in steel foundries where defects in steel castings were repaired with the carbon arc. Blow holes and shrinkage cracks are easily and quickly repaired with the arc at a very small cost compared to the actual cost of the casting. Foundrymen were quick in seeing this great value of the arc welder.

The railroads were perhaps the next industry to take up arc welding on a large scale. The chief uses of arc welding in the railroad shops are: welding flues in flue sheets, fire box welding, welding side sheets, tube sheets and door sheets, building up worn surfaces of steel castings, repairing broken frames and other steel castings, repairing shop tools, building up flanges on driving wheels, and general maintenance of freight and passenger cars. Locomotive companies are using the process in the construction of new fire boxes, thus eliminating all rivets and any trouble from leaking seams. The construction cost is also materially reduced.

During the great war, and since that time, tremendous developments have been made in the ship-building industry with the arc welding process. Present rules permit the use of welding on a large number of minor parts requiring very little strength and also on a few strength members. Such items as deck stanchions, collars, smoke stack pipes, ventilators, skylights, stairs gratings, tanks, deck houses, etc., welding is approved and a considerable saving is made over riveting. The most important work done by the arc on board ships is the repair of boilers. Owing to the strain placed upon the boilers by the rolling and tossing of a ship, the riveted seams of the shell and fire box develop leaks which are easily repaired with the arc. Corrosion and deterioriazation takes place very rapidly in marine boilers and here the electric arc gives a quick and efficient method of correcting same. The welding of fire cracks, staybolts, and mud rings is also quite common practice.

On street railways and interurban lines, the arc is found very valuable for track maintenance, and general shop repairs on rolling stock. Cupped rails and worn rail crossings are being built up with the arc process in a cheap and very satisfactory manner. In the repair shop, many parts are reclaimed such as brake beams, journal boxes, step hangers, bearings, brake shoe heads, etc.

In the manufacturing and industrial field the arc welding process is having a very rapid growth. In the fabrication of steel products of all kinds the arc process is generally cheaper, stronger and better appearing than the old riveting process. In the making of concrete machinery, one of the largest manufacturers has recently changed from a riveted type to an all welded type of steel mixing drum on various sizes of concrete mixers. Also many other parts of the mixer are welded such as levers, chutes, frame work, reinforcing bars, etc. This results in a remarkable saving in labor and machinery and a better product at a reduced cost. It can be safely stated that in any manufactured product made of steel bars, angles and sheets, that the arc welder will produce at least equal results to the riveted construction at a reduction in cost of 40 to 60 per cent of the riveting method.

Electric welding of pipe lines and storage tanks has also become a common procedure. Low pressure air, gas or steam pipes, also dredge pipes, can be welded very cheaply and satisfactorily with the arc. Only a short time ago a 3,000,000 cu. ft. gas holder was erected in Melbourne, Australia, which was 200 feet in diameter and equipped with three telescopic lifts 30 ft. high. There was over 20 miles of lap welded seams and only a very few pin holes were found after the welding was completed.

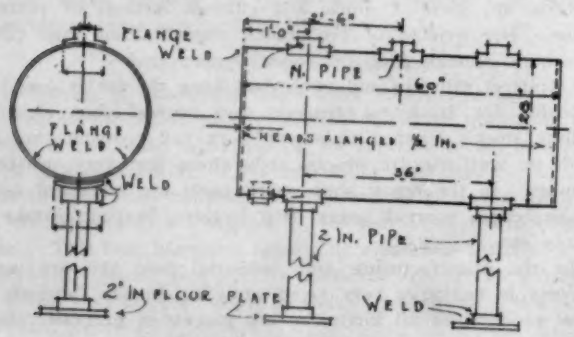
In the structural steel field for building structures, etc., arc welding has not been made use of to any great extent, mainly because of the lack of confidence in the process on the part of architects and engineers. A few structures, ranging from small storage sheds to 40x100 ft. buildings have been erected throughout different parts of the country without a single rivet used, all structural members being electric welded. A 125x16 ft. cross channel barge, also a 500 ton coastwise vessel (Fullgar), were constructed in England completely arc welded throughout. Several 40-ft. diameter oil storage tanks were constructed in Oklahoma with entirely satisfactory results. Undoubtedly there is a big future in the structural field for the arc welding process and the building departments of our various cities will soon recognize this as a standard method of construction, in the same way that reinforced concrete construction is recognized today.

T A N K W E L D I N G

Welded Tanks Eliminate Leakage Losses—Selection of Material Welding Practices—Examples of Tank Welding

THE small metal tank field is an extensive one, as almost every industry uses tanks of some description. The oxy-acetylene process has demonstrated its value for fabricating all types of small tanks, both by reducing construction costs and by so improving quality as to give better and longer service than tanks constructed by the old methods. The use of oxy-acetylene welding for this purpose has grown to be one of the most widely used applications of the process, and it is constantly growing to greater proportions in order to meet the demand for stronger, cheaper and tighter tanks.

Welded tanks may be divided into four classifications, namely the light sheet metal group, consisting of tanks and containers built of lighter than 10-gauge material; the large storage tank and gas holder group; the pressure tank group; and the large group consisting of small tanks used for general purposes.



All Welded Fuel Oil Tank.
For use with domestic oil heating appliances. Capacity, 150 gallons. 14 gauge blue annealed sheet. Note: Welded pipe standard and saddles.

This article is confined to the fourth subdivision. Tanks of not over 500-gals. capacity and built of ⅛-in. to 3/16-in. thick material only will be considered. The capacity limitation is assumed arbitrarily as the lower limit of the second subdivision class of the storage tank field.

Most small tanks may be variously classified as interior and exterior storage, rectangular, open-top, jacketed, mixing or underground storage tanks. Although there are many varieties of each type the materials and methods used for their construction are very similar.

The demand for permanently tight, economically produced, small metal tanks is growing daily all over the country and is being partially met by the heavy sheet metal, boiler and welding trades, each of which is especially qualified to construct welded tanks of this kind. Many shops employing these trades are now engaged in welded tank construction. Yet, many others, ideally situated and equipped for such work, have not taken advantage of the business available to them probably because their managements have not appreciated the facilities they possess or the market for oxy-acetylene welded tanks. For similar reasons industrial plants may go to great expense or entirely forego needed improvements on account of the cost and character of tanks constructed by old methods.

From whatever angle the subject is approached the superiority of the welding process for fabricating all types of small tanks is demonstrated. Tight, leakproof joints may be produced cheaply and easily. Odd shaped and special tanks present no difficulties, and tanks may be fabricated in inaccessible places where it would be impractical to install a tank built elsewhere. Welded tanks are cheaper to manufacture than tanks of other construction, and are often lighter for the same capacity and strength. And finally, tanks may often be fabricated by welding from discarded or scrap material with consequent important saving in cost even as compared with welded tanks made from new material.

Preparation of Material for Welding

The kind, thickness and size of the sheets to be used will be determined by the purpose, capacity and design of the tank to be built. Under some conditions the thickness is prescribed by insurance or other regulations, while in some cities the fire laws govern the construction of tanks used as containers for inflamable or explosive liquids. Galvanized sheet is preferable for some purposes and peculiar conditions of placement will sometimes recommend the use of extra heavy sheet. The builder must carefully consider all the requirements demanded of the welded tank when planning its construction and selecting the material from which the tank is to be made.

Unless material is on hand a careful estimate of what is required for a tank of given dimensions is well worth while, because much material can be wasted if sheets of a size that are not adapted to the tank dimensions are used. Stock sizes, of course, are most economical and the largest size usable is best as it requires the fewest seams.

When material is bought from a mill specified sizes can be obtained, but unless a quantity of tanks is to be built, material is usually obtained from local stocks where frequently exact sizes cannot be procured. Although this may prove an inconvenience it offers no real obstacles to the builder of welded tanks because odd-sized sheets can be fabricated easily and economically with the oxy-acetylene process.

The shell sheet or sheets for round tanks should, of course, be the same length as the circumference. The end sheets may be the same size, in shortest dimensions as the diameter or slightly larger if the edge is to be flanged. Ends of tanks may be made from narrow sheets by welding segments outside of the central section.

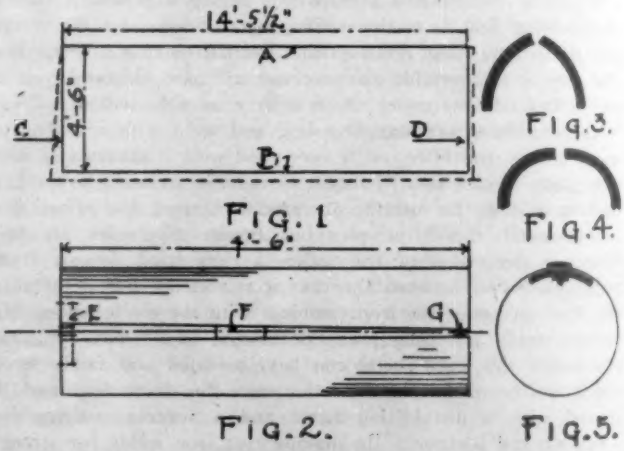


FIG. 1. FIG. 3. FIG. 4. FIG. 2. FIG. 5.

Preparation of Material for a Round 500 Gal. Open Top Tank.
Fig. 1. Layout shell so that edges A., B., C. and D. will be square and true.
Fig. 2. The shell rolled and ready to be welded. E., Clamp. F., Wedge. G., tack weld. The weld is started at G.
Fig. 3. Possible shape of the shell edges should be pounded into the shape shown in Fig. 4, about ⅛ in. below the true circle before welding.
Fig. 5. End view of shell showing clamp in position.

Dimensions of a rectangular tank will also determine accurately the proper material sizes. If the sides of such a tank are to be formed by bent sheets the bending process will not appreciably affect the dimensions of the sheet of the thicknesses considered in this article.

Methods for forming and shaping sheets are necessarily dependent upon the equipment available. Shops having access to pressess and rolls can, of course, accomplish this phase of tank construction to the best advantage. If quantity production is to be carried on the usual sheet metal shop equipment, including shears, rolls, presses and throatless shears, for round and curved sections, are almost essential. In some localities it is possible to purchase sheets formed to specification, and it will often prove economical to buy this way if mechanical facilities for forming sheets in the shop are not available.

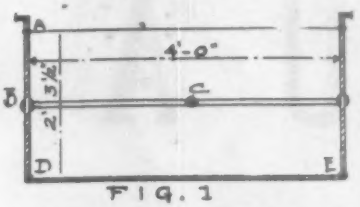


FIG. 1

FIG. 2.

Reinforcing or Stiffening the Sides of a Rectangular Tank.
Fig. 1. A., angle iron tack welded to top edge. B., tie rod welded inside and out. C., welded joint in center of tie rod. D. and E., butt welds.
Fig. 2. Detail of welded joints. F., J and K., angle iron. G. and H., upper edge of tank.

When necessary, however, to form light sheets in the welding shop the lack of machinery should not prove a serious handicap in oxy-acetylene welded tank construction on a moderate scale. The most ordinary equipment is often sufficient to form light sheets. Cylindrical shells can be formed by bending and pounding the sheet over any round shape and the edges can be flanged with a block or vise and hammer. Rectangular sections are easily bent with a sledge over the edge of an I-beam. A simple "home-made" press can be built of two I-beams, one rigidly fixed to a solid base and the other suspended and so supported that a lever can be attached to bring it with force past the fixed I-beam. A sheet placed between the two may be quickly and sharply bent to the angle desired.

Bending ¼-in. and heavier sheets into cylindrical or rectangular section without machine tools can be faciliated to a great extent by first heating the parts to be bent with an oxy-acetylene blowpipe.

If shears are not available an oxy-acetylene cutting blowpipe is an effective, quick and economical means of cutting sheets to size. In fact, under some conditions and unless a quantity of material is to be handled, as it is a cheaper and more adaptable method of cutting, the cutting blowpipe is preferable. It is advisable, however, to clean the cut edges so that no slag will be included in the weld.

Unless the tank being considered is to be used for some unusual purpose the heads, bottoms or tops need not be dished, as the pressures encountered in the type of tanks being considered are not sufficient to warrant this. Flanging these parts will often aid in welding them to the sides or shell. Dished heads often add to the appearance of a tank and simplify the handling of contraction strains.

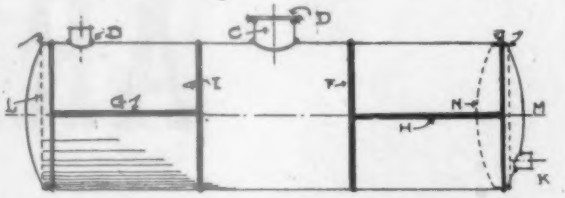
The edges of sheets ¼-in. thick and heavier should be beveled to about 45 degrees to permit proper welding practice. If the beveling cannot be done when the sheet is sheared it can be effectively accomplished with an oxy-acetylene cutting blowpipe.

Sheets ⅛-in. thick and lighter, after being formed to the required shape, do not require special edge preparation for welding. Heavier sheet, on the contrary, requires beveling and more careful attention in forming so that misfits and poorly matched sections will not be encountered in the welding.

Much can be gained in speed, accuracy, and workmanship if drawings including layout of sheets are furnished the welders. If the tank is designed in the shop rough drawings or, at least sketches will tend to eliminate delays and inaccuracies which often result when work is attempted without the proper working plans.

It may often happen that the welder can find ways of constructing a tank more economically and to better advantage than contemplated by the designer. Frequently an experienced welder has a better knowledge of the preferred practices in his trade than an engineer or designer specializing in other lines.

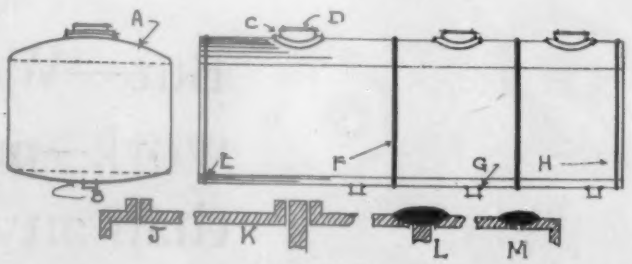
Jigs are a great help in welding long seams in sheets ⅛-in. and lighter. The jig may be a temporary holding device consisting of flat straight-edges to weight the sheet down or to which the sheet edges can be securely clamped. It may also be a permanent device designed and constructed to meet special requirements particularly in production work. As long, however, as a device serves to securely hold the edges of the seam in the



Sketch for an Oxy-Acetylene Welded Horizontal Oil Storage Tank.
A., end of shell. K., welded fitting. C., manhole. E. and F., circumferential joints. G. and H., longitudinal joints. N, end may be dished.

correct position and easily accessible to the welder the requirements of a jig are fulfilled. Jigs for quantity production can be so built so as to be semi-automatic in operation, water-cooled and possess other refinements to expedite and improve the work.

Expansion and contraction due to the heat of welding are probably the most important factors, beside good welding practice, to be considered in tank welding. These two factors can be controlled to a large degree on short lengths of light sheets by tack welding the edges. The edges of the seam should be tack welded apart at from 2½ to 6 per cent of the length of the weld and then weighted down with narrow strips of steel. If no temporary jig is available tack welding at intervals of 2 to 6 in. should suffice for emergency purposes. When this method is used and the welded shell proves slightly deformed it can be re-rolled or hammered again to the proper shape and diameter.



Truck Tanks
At right—A sketch of the tank shown in the accompanying illustration of the Magnolia Petroleum Company's truck. 500 gal. capacity, outside beads and shell No. 10 steel sheet, partitions No. 12 steel sheet. All welded construction. C. and D., Manholes. G., Fittings. E., F. and H., Welded Joints. J. and M., Detail of End Joints. K. and L., Detail of Inside Joints at F. No filler rod is used with this type of joint. Note formed bottom. Top and sides are formed as one piece.

Some provision, however, must be made or mechanical means employed to counteract the forces of expansion and contraction in the sheet during the welding. These forces tend to draw the edges apart when the welding is begun and afterwards to gradually draw them together until the edges finally overlap.

More effort is necessary to handle expansion and contraction in sheet ¼ in. thick and heavier than is required for lighter sheet, as the heavier section has a proportionally greater power of contraction unless adequate separation of the sheets relieves the strains. When proper procedures in controlling these forces are carefully followed there is slight danger that expansion and contraction in the sheet will either prove a hinderance to welding or have any ill effects upon the finished work.

Clamps and wedges have been found to be the best means for holding work in position for welding. The end of the seam where the welding is started can be tack welded into place. A

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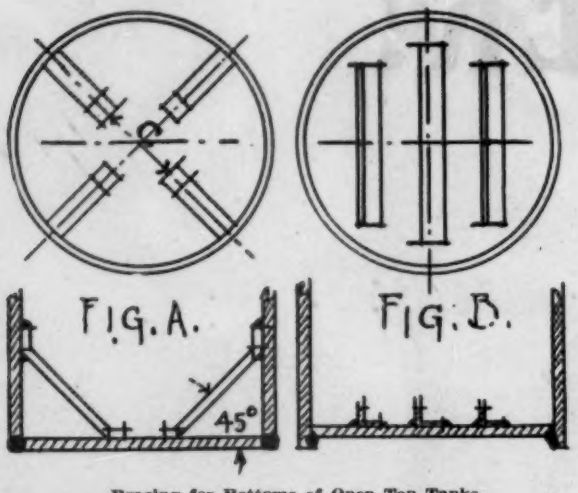
clamp made of two strips of the same thickness of metal as the tank, bolted or clamped to the other ends of the seam and bent to conform to the circumference of the shell will hold the edges apart and in the proper position. Clamps or bolts should not be drawn up so tightly as to prevent the edges drawing together gradually as the work progresses. Ordinarily it is the practice to separate the edges in this way about ⅛ of an in. at the end opposite the start of the weld for each foot of the length of the seam. A wedge, having a fairly long point, can be inserted between the edges about two thirds of the length of the seam away from one end at which the welding is started as an additional means of holding the edges apart. As the welding



Brazing for Bottoms of Open Top Tanks.
Fig. A. Band iron tack welded to side and bottom C approx. ¼ the diam. Fig. B. Angle iron tack welded to bottom.

progresses the wedge should be moved along the seam and finally taken out with the end clamps when the work nears completion. A spring leaf or any V shaped piece of metal will serve this purpose.

In welding long seams in this thickness of metal it is necessary to keep the two sides in the same plane. Otherwise the joint will be unsightly and may be poor in quality. An automobile spring leaf ground down to a fine edge or a crow bar may be used to raise the depressed side of the sheet. Unless jigs hold the sheets properly some means must be employed for accomplishing this purpose.

If the length of a round tank requires more than one cylindrical section the longitudinal seams on each section may be welded before the circumferential seams but an excellent method of building long cylindrical tanks is to make the longitudinal weld of one ring, then join the next sheet at the circumference of the first ring and follow by welding the longitudinal seam of the second ring. The ends or bottom and top should be welded in last.

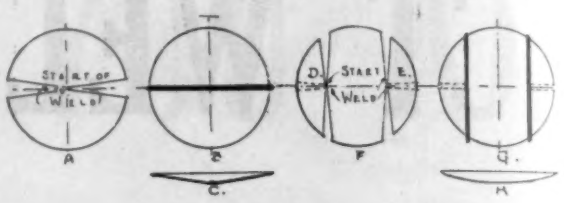
Corner joints are not objectionable in tanks that are not subjected to high internal pressure. As it is the tendency to use heavier sheets than necessary to withstand pressure exerted by the weight of the contents in order to obtain either additional wearing qualities or stiffness, corner welds can be considered good practice for the types of small tanks being considered in this treatise. Nevertheless additional strength can be obtained by avoiding corner welds and locating the joints in the body of the tank. To do this will manifestly require additional work and more expense in the preparation of material.

The most common and easily prepared joint for the side seams of round tanks and the sides of rectangular tanks is the butt weld. The lap weld should not be used on this type of tank construction.

The form of joint for use on the end of round tanks and the bottoms of rectangular tanks will be determined by the thickness of the sheet, size of the tank and the weight of the contents. If, for the sake of additional strength, the end or bottom sheet have been dished or flanged, welding the joints is simplified. Variations in the type of joints that are recommended for different purposes are illustrated and described in the accompanying drawings.

Rarely is it necessary to reinforce or brace round horizontal storage tanks. It is more economical to construct a base or foundation of conventional design to distribute and carry the load. But, there are numerous occasions when it is beneficial to brace and reinforce the top and sides of rectangular, open-top tanks.

This can usually be accomplished easily and economically by cutting angle, band or bar iron to size with the cutting blowpipe and then tack welding it to the section of the tank



Built Up Tank Ends.
A and B containing two welded sections. F and G containing three or five welded sections. C and H show the shape of the ends after welding—accomplished by spacing the pieces before welding as shown in A and F.

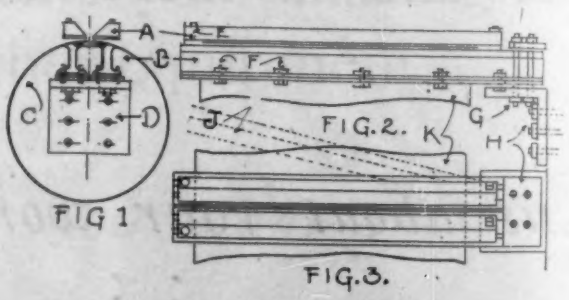
which it is desired to strengthen or stiffen. If preferable, the bar iron can be heated with the blowpipe and bent to the required shape. This makes the use of bar iron preferable to angle iron as the latter is more difficult to shape. The ends of the bar or angle iron should be welded together. One should not attempt to more than tack weld these to the sides of the tank as continuous welding after the tank has been fabricated tends to buckle the sheet.

Welding Practices

Of equal importance to the proper preparation of the material are correct welding practices. If either is neglected the work is bound to suffer.

Penetrating the full depth of the seam and completely fusing the metal throughout its thickness are foremost requirements in welding tanks. Unless these are accomplished a good weld cannot be produced. The projection of the welding flame is great enough to fully penetrate the depth of the seam on light gauge sheets. On heavier sheet, however, beveling, referred to before, is necessary to form a vee about as wide as the thickness of the sheet to permit full penetration.

A neutral flame is also very essential and an operator working on sheet steel and iron should always be careful to maintain



Jig for Welding Light Sheets.
Fig. 1. End view A, jaws. B, old rails. C, shell. D, bracket bolted to wall or column.
Fig. 2. Longitudinal section. E, pin holding end of jaw in place. G, bracket.
Fig. 3. Plan. J, open position of jaws. K, shelf.

such a flame. The apparatus manufacturers' tables should be followed for the correct size welding head or tip to use on various thicknesses of metal. Use of oversize tips or of higher pressures than prescribed usually results in "burning" of the deposited metal.

Ability of welders may be easily and accurately checked by placing strips of welded sheet in a vise, the weld being flush with the face of the vise, and hammering the projecting part of the sheet until the material is bent to right angles or the weld has failed. A study of a failed weld will disclose the cause of

fracture which may be due to any or all of the above mentioned causes.

Some sheets of steel may not weld properly which can be checked by first assuring that the welder does good work on some satisfactory steel. In light sheet steel a properly made weld should bend to ninety degrees without cracking.

Either welding by sections or continuous welding can be employed with equally good results. The former is done by first playing the flame along the edges for a short distance as a preliminary heat treatment, then fusing the lower edges together for about two inches without adding any filler material. It is important that this phase of the weld be carefully and completely done in order to assure full penetration. This much accomplished, the welding of the two-inch section is completed by gradually adding metal from the filler rod in ripple layers. The end of a completed section is then fused to the bottom of the last two-inch section completed and the operations repeated to the end of the seam. The welding progresses by these small sections, each being completed before another is started. In continuous welding the welded section advances with each addition of the metal which is made to slant toward the bottom of the vee. The filler material is added continuously to a sloping plane so that the edges of the seam are fused as a part of each layer that is added.

In tank welding when a single vee weld is used a heavily built up joint is not recommended. If sufficient filler material is added to build the weld up not more than fifteen per cent of the vee depth above the surface of the sheet, the best results will be obtained. Should the joint be built up in excess of this amount the inside or under part is weakened by the heavier upper section acting as a fulcrum on the weld. It must be understood, however, that this applies only to single vee welds, that is, welds made from one side of the sheet only. In welding from both sides reinforcement is advantageous up to twenty-five or thirty per cent.

A good quality of filler rod is essential. Ordinary wire or strips cut from the sheet usually do not possess the qualities required of a welding rod. Only a rod that is specially prepared for welding purposes and has the correct chemical and physical properties should be used. When this matter is disregarded and rods of questionable quality are used, regardless of the operator's skill there is no assurance that a good weld will be obtained. Copper coated drawn iron rod clean and free of dirt and impurities and low in carbon, is recommended.

Flux is not generally used in welding sheet steel.

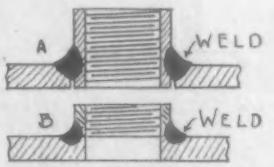
One of the most economical features of tank construction by the oxy-acetylene process is the effective manner with which the process lends itself to the utilization of used and scrap material. Discarded flat sheets or old devices from which such sheets can be cut are to be found in almost every industrial plant. If not, such sheets can often be purchased far below the cost of new material.

Open top tanks, round or rectangular, and even some types of storage tanks, can be and are being constructed entirely of scrap material with the oxy-acetylene cutting and welding blowpipe. Used sheets for the shell or sides and ends or bottoms can be cut to shape and size so they can be welded together to almost any desired form. The round shell of used sheets may be formed with several longitudinal or circumferential seams and the ends or bottoms formed by welding pieces together and then cutting round or rectangular sections from the built up sheet. Sections for rectangular tanks may be formed from almost any size sheet. By cutting and welding an operator can often fabricate such a tank with no other tools than an oxy-acetylene outfit. A quantity of lubricating oil tanks recently built by a large oil pipe line company from old smoke box iron which ranged from 10 gauge to ¼ in. thick, is an illustration of what can be accomplished with scrap sheets. The sheets for the shells were cut to size with the cutting blowpipe and measured 4 x 10 and 5 x 10 feet. These were rolled to form and round sections were cut from the same stock for the ends. These tanks were fabricated entirely by welding, and as the smoke boxes had been scrapped the tanks were built for the cost of the labor and gas alone.

Steam, water or air jacketed tanks can be constructed by welding because of the flexibility of the oxy-acetylene process in fabricating unusual shapes or sections. As such types of tanks are usually built to meet special requirements the cutting blowpipe will ordinarily prove the most economical means of cutting the material to size.

In fabricating jacketed tanks it is, of course, of the utmost importance that the jacket seams be tight. Experience has demonstrated that best results are obtained by building such tanks in complete sections and then assembling these. The methods of preparing the sheets and welding the seams are the same as described for other types of tanks.

The construction of an irregular shaped tank is as easy and economical as regular shapes as far as welding is concerned.



PIPE CONNECTIONS
A and B continuous welds.

MANHOLE
All welds continuous.

Particular care, however, must be taken in preparing and forming the material so that the joints will fit together. Contraction and expansion in irregular shaped pieces can be controlled by the same methods used on rectangular tanks.

If the material is prepared on a quantity production scale or if mechanical means are available it is, of course, more economical to have the openings for connections cut in the sheets before the tanks are welded. If the work is being done entirely in the welding shop better results are obtained by cutting the desired openings with a cutting blowpipe after the tank is fabricated. Doing this obviates the danger of misplaced openings and enables the builder to conveniently adapt any changes in the position or size of connections desired. When making such cuts with the cutting blowpipe the outside edge of the cut should come inside the extreme measurement of the opening, and should thus be in the piece to be removed.

The accompanying drawings show different methods of welding fittings to a tank. Whenever possible it is recommended that welded flanges be used on such connections.

As tightness is the principal requisite of a tank of any sort it is essential that the welder test his work to ascertain that the results are as desired. The most practicable way to test an open-top tank is to fill it with water and tap the seams with a mallet. Tapping will bring to light any defects in the welding or hidden stresses that have been set up by expansion and contraction and which might not be discovered without test tapping until after the tank is in service. Any defects can be rewelded to make the tank absolutely tight. Caulking invariably proves to be an expensive method of correcting defects and should not be employed.

Storage tanks, horizontal and vertical, can be more thoroughly tested than open-top tanks. The best and customary method of testing these is to tightly close all openings and then fill the tank with air under pressure of from five to ten pounds per square in. and go over the seams with a brush and soapy water. Or if more convenient, the tanks can be filled with water, and then pounded, not too severely, with a hand hammer or mallet. To give the welded seams a more severe test the water in the tank may be put under from five to ten pounds pressure, per square inch.

When galvanized sheet is used care should be exercised to restrict the portion from which the galvanizing is burned to as small an area as possible. By carefully manipulating his blowpipe an operator will be able to restrict the burned area to not more than ¼ of an in. on each side of the seam. Those who are practiced in welding galvanized sheets can, however,

(Continued on page 46)

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How Do You Advertise Welding?

AN investigation of the wisdom of launching a big national advertising campaign to advertise welding, as a process, to the general public will naturally seek to discover whether or not the time has really come to make such a vigorous move, for if such a thing were done prematurely some handicaps to future progress might easily be developed. If it be assumed that co-operative national advertising will some day become a necessity, what about the foundation of the campaign? It certainly will be laid in the present activities of the industry. Every man connected with the industry today is doing his share to help or retard the progress of tomorrow. If he is a welder, does he overstate his own ability and knowledge, or does he admit his limitations and seek methods to improve them? If he is a shop owner does he give the customer the benefit of a business-like cost system of operation or does he go the limit with his changes? If he is a salesman, does he sell goods on their own merits, or does he depend upon wild stories of the defects or inefficiency of all other equipment and all other processes? These are the men who are supplying the copy for the advertising which welding gets today. Advertising men are fond of the theory that a satisfied customer is the best form of advertisement. For its verification as far as welding is concerned, witness the splendid publicity which has been furnished by Mr. Wagner, of the Prairie Pipe Line Company, and Mr. Sloan of the Vilter Manufacturing Company, and about a score of other satisfied "customers" of welding. The ideal condition would be to have every user an enthusiast. The responsibility of creating such a condition is divided among many men in many places, but none of it can be shirked if the industry wants to grow. What small difficulties exist now can be overcome if individuals do their several shares to keep welding high in the esteem of those who buy it, so that their support can be enlisted in selling to those who ought to buy it.

Training Welders on Short Notice

IT is not uncommon to hear one welding supervisor claim that it takes several years to make a real welder and be closely followed by an equally successful man who claims to have them on the job in a few days. This causes confusion in the minds of the investigator, yet they are both right. General repair welding can be handled only after long experience in distinguishing between various metals, knowing for what service they are intended and how to weld them. But some men can be broken in on special forms of production welding on rather short notice. It takes an expert to break them in that way, though. He has to know when the metal is acting right in the puddle or the crater, and have the good judgment to turn away men who cannot grasp the fundamental principles. Even pressure work can be picked up quickly if the instructor is equal to the job of imparting enough of the necessary information, and there are plenty of good pressure welders who were doing real work soon after they made acquaintances with the torch. The danger is that these welders may grow into the impression that they are all around experts. They may be total failures at welding a new metal, or the same metal of a different size. Here is where continued instruction, after the desired proficiency had been reached on the work in production, would be valuable. An introduction to some of the unguessed problems and possibilities of the welding process would tend to remove that dangerous overconfidence, and the increased knowledge on the part of the operator would make it possible to extend the uses of the apparatus. It cannot be denied that specialists can be trained quickly, but a little knowledge is a dangerous thing, while a thoroughly trained workman is a decided asset in any plant.

The Test of Time

In the years since Acetylene first became a commercial product, users of the gas welding and cutting process have been offered many substitute fuel gases. Unwarranted claims for these substitutes have failed to stand the test of time and actual performance.

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DISSOLVED ACETYLENE

AMERICAN WELDING SOCIETY PUBLISHES PRESSURE VESSEL REPORT.

The report of the activities of The Pressure Vessel Committee of the American Bureau of Welding has just been published in the Journal of the American Welding Society. The report covers 152 pages, and gives a very thorough description of the work of the Committee.

In the introduction, the events leading up to this investigation are outlined, and acknowledgment is made to the firms and individuals who have co-operated. Then follows the recommendations made by the Committee for the consideration of the Boiler Code Committee of the American Society of Mechanical Engineers in their revision of the Code for Unfired Pressure Vessels. The recommendations cover the removal of certain restrictions on welding, and rewording portions of Code which have reference to specifications of material to be welded, and the material used for welding rods and wire. It is also recommended that the routine of inspection be simplified and that the rules relating to methods of welding be somewhat modified. Further recommendations call for the omission of some portions of the present Code and for retaining the hydrostatic test.

Following the recommendations of the Committee, is an Analysis of Test Data given in the report of the Bureau of Standards. Here the comments on construction are very complete with reference to all types of tanks used in the investigation. The subject of design is also given a thorough discussion, and illustrations are given of recommended head, flanged and nozzle designs. The comments of the Bureau of Standards on the hydrostatic hammer test furnish the following conclusions. A hammer test cannot be relied upon to show more than a very few exceptionally defective welds. The hammer test, as applied, apparently did not weaken the tank. Hydrostatic pressure 1½ times the working pressure showed only a small number of imperfect welds, even when the hammer was used. The Committee in its report agreed entirely with these conclusions, but takes occasion to add a further discussion on the subject of these tests. At this point in the report are included some remarks made by H. W. Heinrich of The Travelers Insurance Company, at the Welding Conference held last February. In these remarks satisfaction is expressed with the insurability of welded pressure vessels, although greater stress is placed on the importance of construction than upon tests made after construction.

The report commends on the physical qualities of materials used on mechanical requirements of a plate and on the welding wire used. A description is given of tests of welding specimens in a tensile testing machine, the test pieces being struck with a hammer while under load. The results of all these tests are carefully tabulated and the conclusions drawn are that tests of the type carried out seem to be as consistent with the results of the tank test as could be expected, that welds of reasonable quality are not injured by severe shock under heavy tensile stress, and that the Double Vee Weld is stronger than the single Vee.

Then follows the report of flattening tests of welded pieces. This test was intended to simulate the action under internal pressure of a badly shaped tank, as for instance one which had not been properly rolled before welding or which had been distorted during welding.

In connection with Paragraph U-101 of the Boiler Code, especially that portion which deals with the matter of marking and stamping, the reports suggest that one mark in the center of each head would seem to be enough, that only one mark near the edge of the shell sheet, would seem to be necessary, and that a name plate properly secured to the tank might be a substitute for much of the stamping required by the Boiler Code.

Appendix A, of the Report, consists of the Bureau of Standards report on the Investigation of Strength of Welded Pressure Vessels. Following is the table of contents of this report.

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A number of photographs are included to show clearly the methods of testing and appearance of tanks, the completion of tests and close-up views of the breaks which were found when the tanks were tested to destruction.

Conclusions reached by the Bureau as the results of these tests are:

1. The double Vee weld is much superior to the single Vee weld.
2. The pipe shells tested were less uniform and averaged lower in strength than double Vee welded plate shells. This should be investigated further.
3. The butt welded heads were stronger than the inserted heads.
4. A hammer test cannot be relied upon to show more than a very few exceptionally defective welds.
5. The hammer test, as applied, apparently did not weaken the tanks.
6. Hydrostatic pressure 1½ times the working pressure showed only a small number of imperfect welds, even when the hammer was used.
7. Hydrostatic pressure sufficient to stress the shell to the yield point will show a large proportion of imperfect welds.
8. Hydrostatic pressure sufficient to produce a permanent set in the shell, enlarging the circumference ½ per cent, apparently does not weaken the tank.
9. Flanges for inspection plugs can be welded in the heads of a tank without weakening it.

This report has been published in bulletin form by the American Welding Society, and copies can be secured from the Secretary of the American Welding Society, 33 W. 39th St., New York City, at the cost of $1.50 per copy.

WELDING A CYLINDER BLOCK

By Harry Witt

Some time ago a farmer brought in a cylinder block which was badly broken when the connecting rod broke and caused the piston to go too far and knock out the cylinder head. The piston head was broken at the same time. I had to cut out the side wall to get at the cylinder head, then I preheated the casting in a brick furnace to a nice red heat. I welded it while it was red hot, and left it in the furnace to cool. When the weld was cold, I dressed the outside of the cylinder with a grinder where it had been welded. I painted it over carefully so that nobody could tell that it was ever welded. I find that it pays to finish off all my welds in this way so that castings do not show that they have been worked on.

Hints for the Welder

When you finish an interesting piece of work, can you set down on paper the manner in which you went about the job, how you prepared the work and how the job was done? Have you learned some little stunt every welder ought to know? Contributions to this department are paid for. Write it down any old way – I'll polish it up. Make a rough pencil sketch, and our draughtsman will fix it up fine. Line drawings are more practical than photographs. Do it today – the men on the firing line are waiting. L. B. Mackenzie, Editor.

CUTTING CAST IRON

By Alfred Wilkins

To welders who still insist that cast iron cannot be cut with a cutting torch, the following experience may prove interesting. It was necessary to scrap a large fly-wheel to make room for other machinery and so the plant welder was sent for and after trying the best he knew how to cut the wheel with the oxy-acetylene flame, declared that the job could not to be done. I was appealed to and asked to come and look the job over and see whether I could do it or not. As I resided about sixty-five miles from the plant in question, I took the first available train and after looking the job over I told them I could do it. The job required twenty tanks of oxygen and five tanks of acetylene which had to be made available before the job was started. The wheel in question was eighteen feet in diameter and four feet across the face. The mean thickness of the rim was three and one-quarter inches, it being reinforced in the center and outer edges making the diameter from six to seven inches at these points. There were eight spokes approximately four by eight inches at the rim and six by twelve inches at the hub. I cut the rim in two six times, and cut each of the spokes off at the rim and hub. I did the rim cutting from a scaffold so that the cutting operation might be as near straight down as possible, making all of the cuts in the rim before removing any of the wheel, thus keeping in balance so that it could be easily rotated. The entire cutting operation consumed about thirty hours and was done without preheating. The cutting was largely an oxidizing process. There being a certain knack to the cutting of cast iron, it must be learned by degrees.

The writer has been over a year acquiring the knack of successful cutting of cast iron, but is prepared to make the statement at this writing that cast iron can be successfully cut with the oxy-acetylene flame.

BRAZING CAST IRON

By G. H. Hale

Once in a while the welder in a job shop will get some work in that must be got out at once, or quicker, if possible, like the job I had not so long ago. It was the base of a radiator of a Samson tractor. It had been frozen and cracked clear across from end to end and the bottom crack was open a good eighth of an inch. Now the good farmer was in a big hurry, as they all are now, and couldn't wait for me to preheat and weld in the proper way; so I had to do it another way. Now I have been practicing or experimenting a good deal with brazing and found out how to braze cast iron so the brass would stick to it, so I went at this job with an understanding with the owner that I might fail but would do my best.

We all know brass or bronze won't stick to cast iron, so I took some scrap malleable iron shavings or filings and mixed it with the bronze flux, about half of each, then I heated the cast iron around the crack for about five minutes. Then I started at one end, getting the cast iron hot enough to almost melt, but being very careful not to melt it. Then I put the hot Tobin bronze rod in the flux and shavings and touched it on the end of the crack. The iron stuck at once with aid of the flux, then a drop of bronze, and the weld was started. I went about one-third the length of the crack, then I began at the other end the same way and brazed about two and one-half inches, then back to the other place and went about two inches more, and so on until I made the braze complete in the middle. I was very careful not to get it too hot in any one place, but kept playing the braze around on the sides of the casting to keep the heat even. When completed I covered it up in lime about a half-hour. The farmer wanted it right away as he had twenty-eight miles to go and it was 3 P. M. then, but he was to let me know how it was after cooling. The next week he came in and said it didn't leak a drop and that his man was using it every day. That job cost $1.25 and he said that it was worth all of that just to have the job done so quickly.

Since then I have brazed two cylinder blocks and one crank case without preheating but I do not advise anyone to try it till they have practiced on scrap. It is not easy, but I will say that if the brazing is done carefully, it can't be chipped off with a chisel.

A FAST REPAIR ON A REAR AXLE

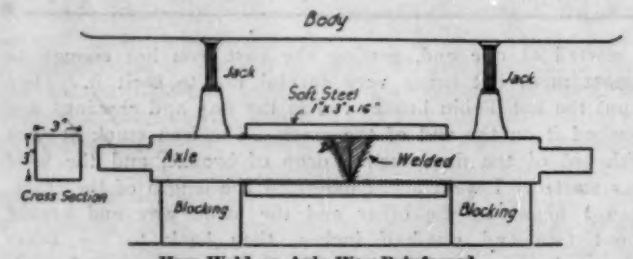
By L. F. Armort

Late one Saturday afternoon the California Truck Co., drove up to my shop and informed me that they had a little job for me and would have to have the truck for duty Monday morning. I went to look and saw a lot in a little while. It was a five-ton Moreland Truck with the rear axle broken right square in two. The first thing that I thought of was Monday morning. The rest didn't bother me. But you know how some women are, they kind of like to have Sunday for themselves and as far as I could see this one meant work.

So I said, "Drive around in the back yard, and you can come and get it Sunday night or Monday morning." I had a man on the job right away and we jacked it up and blocked up under the axle and let the weight down on it. Then we took two jacks and placed them between the body and the axle and jacked the axle down tight on the blocks thus making it straight up and down. Then we took a straight edge and placed along the side of the axle and knocked the wheels around until it came straight that way. This was all for Saturday night.

Sunday morning at nine o'clock found me on the job but all by myself. I took the cutting torch and cut out a piece in a V shape making the cut from the top down. Before I go any further I might say that this axle was a Drop Forging three inches square. So I cut out a piece about three inches across the top and tapered it down to nothing at the bottom. Then I gave it another careful check to see that it had not moved and proceeded to go to work. I

have an Electric Arc Welding Set, and I used a 3/16 inch rod with one hundred and seventy-five amperes, tied it together tight at the bottom, then did some more checking and found that it was still in place. So I took a piece of soft steel 1x3/16 inch and beveled off both edges with the torch and placed on the bottom side of the axle, with the bevels up, and ran a good heavy head into the bevels. This tied the axle and soft steel together so that there would be no danger of displacement when I went to fill the V from the top. Filling in the V took me about three hours and after that I took another piece of soft steel of the same dimensions as that of the bottom and placed on the top and welded in the same manner as that of the bottom, all the while



How Weld on Axle Was Reinforced.

keeping careful check on the axle, and changing from one side to the other so as to keep it straight.

This work took me from nine in the morning until two in the afternoon, and one and one-half hours the day before, when it was ready again for the road.

WELDING AUTOMOBILE FLY WHEELS

One of the common repairs brought to the automobile repair shop is broken fly wheel, and in some of the hilly sections of the country, there is a great deal of trouble caused by tearing out teeth in gears. Welders find it a troublesome job to replace the gears without warping the wheel. In a great many instances the preheating draws them out of shape just enough so they do not fit properly. On the other hand, if they are welded cold or preheated with a torch they are apt to get so hard that it is impossible to machine or file them to fit.

A correspondent describes an interesting experience which he had with one of these cases. A man came into the welding shop with a fly weel which had been turned down by several other repair men and asked if it was possible to get it fixed so that he could have his car the next day.

Taking an extra good grade of tobin bronze, the welder brazed six teeth in the wheel, not all in one place, but in three different sections around the wheel. Before starting a torch was used to burn off all the grease, then the surface was carefully cleaned up with a file, then a template was made of sheet tin, using some of the good teeth for a pattern. In this way he made sure that he could get new teeth built up so that they would fit the starting shaft gear. After enough bronze had been put in to make all the necessary teeth, notches were cut with a hack saw, hammer and chisel, then they were finished off with a file. The fly wheel was then replaced in the car and since it turned over a number of times in a satisfactory way, the customer started off on his trip.

This particular fly wheel has been in the car for two years and has been in use every day since it was welded. The same welder has brazed about a dozen of them since that time, and all of them are reported to give good service. The same method could be used on other type of gears. This same welder repaired several gears for a steam laundry, one 18 inches in diameter and one 24 inches in diameter, the first having two teeth missing and the second three teeth, Both of these gear wheels have been giving good service for a year, so this welder recommends the method in cases where straight welding will make the problem too difficult.

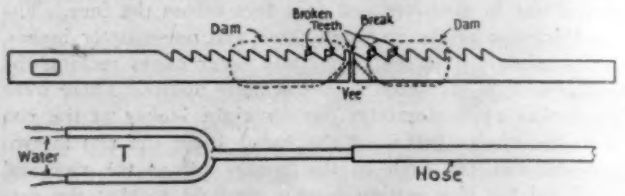
REPAIRING A BROACH

By Geo. F. Walker

This Broach was approximately four feet long and was used for cutting one inch keyways in Nickel Stud Gears, a number being ganged together and cut at the same time. I had had a lot of experience welding high speed tool steel tips to machine steel shanks of various sizes for planers, boring mills and lathes, engine and turret, and always had fine success.

The keeper of tools, jigs and fixtures brought me the broken Broach and said it would tie up a machine for a number of weeks as the makers could not furnish one short of that length of time and incidentally it would cost a couple of hundred dollars he said to replace it. I told him I had my doubts but I would do the very best I knew how. So he decided to stay and help me. This is how I proceeded:

I ground the broken sections to as narrow a working V as possible from the back side, clamped then on a table and lined them up. I then took some asbestos clay and made a dam around each section as close to the V as possible. These I filled with water and made a Tee out of ⅛ tubing and reversed the ends and then told the helper to keep those two dams filled up with water while I welded, using a cast iron flux of carbonate and bi-carbonate of soda. I took a number of one-eighth inch diameter nickel steel welding rods, laid them where they were handy and started to work. Everything proceeded O. K. until the time for the building up of the teeth. I had to unclamp the Broach, make the dams all over again as I had to reverse the piece, all the while keeping water flowing on it. I built the teeth up and then it was ready for finishing. Well they finished it and naturally the teeth were soft. I was as bad off as when I started.



Welding Saved Weeks of Delay When This Broach Was Broken.

To harden the soft teeth without softening the hard teeth was the next problem. After sizing up the situation for some time I happened to hit on a lucky idea. I got a piece of five-inch steel pipe five feet long and welded a bottom on one end giving it the appearance of an annealing tube and filled this right up to the top with fish oil. I wired it to the bench so it would not fall from being jarred and had the helper stand on top of the bench and insert the Broach as far as the last hard tooth. I then took a smaller tip and playing the torch straight across the tooth heated it cherry red and then the helper inserted it into our hardening pot. I proceeded this way until I had heated the whole seven teeth. I forgot to add, I built the teeth up with one-eighth inch diameter drill rod.

The result was the cutting edge of these teeth were hard while the backs were soft and consequently everything turned in my favor. This work was done in 1917 and I just recently returned to work for the same people, and the first person whom I chanced to meet was the chap that helped me on that job and he told me "Our Broach is still holding."

Arthur F. Braid, sales manager of the Metal and Thermit Corporation is planning a summer trip to Europe, starting August 5. He will visit his home in Glascow, Scotland, then London, Berlin, Paris, and Naples, returning early in October.

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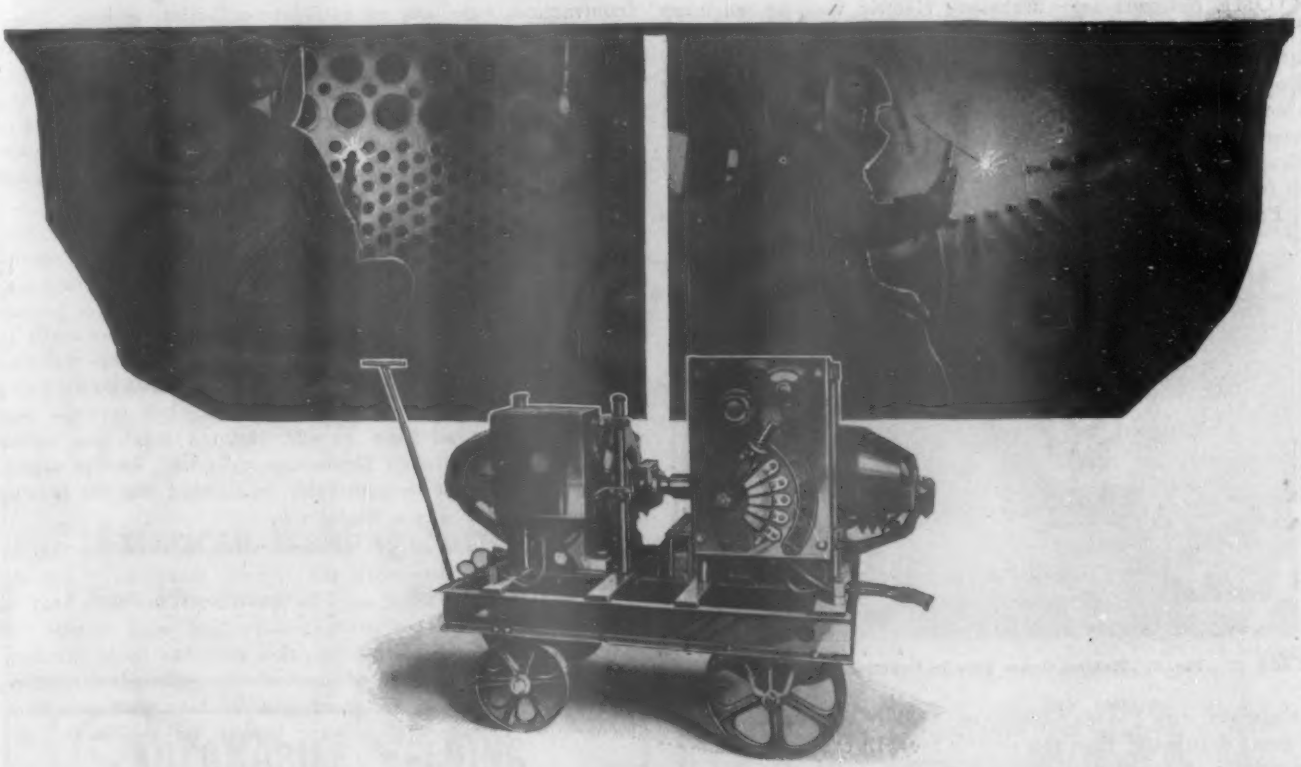

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ARC WELDING CYLINDERS

Use of Special Nickel Alloy Electrode for First Layer Results in Successful Weld on Iron Casting

By B. K. Smith

SOME railroads are purchasing electric welding machines just to weld locomotive flues to the tube sheets, others are using them just to build up, others to weld all steel and cast iron operations, and others to cut off risers on cast iron and steel castings. Oil refineries, are using electric welding to weld seams on stills as well as manifolds, boiler and tank work. Graphic welding is extensively used to build up worn members of frogs, switches or manganese diamond crossings.

For welding or brazing copper, brass, bronze, aluminum or galvanized iron the oxy-acetylene welding flame has proven a great deal better than the electric arc. In cast iron welding, especially in heavy castings, the efficiency of both processes are about equal in value. In welding locomotive flues to flue sheets, the electric arc welding is now considered the favorite process and is done almost in every modern railroad shop. This is due to the fact that the electric arc will develop a high temperature on the beads of the flue much more rapidly than can be done with oxy-acetylene because the gas flame must be played over the surface of the tube sheet and flue is brought up to the melting point; whereas, in the case of the electric arc the current passes from the tube sheet to the filler rod (or welding electrode), thereby concentrating the heat around the flue and the flue sheet.

Fig. 1. Welded Steam Pipe in Cylinder Saddle.

In the past as an old oxy-acetylene welder, I tried my best to find a method to be able to weld flues to the tube sheet with the gas flame and was successful; but the cost of my method was too high and was considered prohibitive. My method was to fill every flue with sand, with the purpose of retaining the heat in the flues, so as to produce a uniform cooling.

When I was at school they taught me that cast iron could not be welded. Years later with the introduction of the oil and compressed air flame, we were able to braze large gray iron castings by heating them to a bright red heat and then, with the aid of a special flux and molten spelter bronze, were able to braze and reclaim such castings. However, this operation required great heat punishment and special skill and after all it was an uncertain operation.

However, when the oxy-acetylene process was introduced, it was possible to weld cast iron with cast iron and thus make a homogeneous weld. The old time brazers were more than glad to abolish the complicated and uncertain brazing methods and with full enthusiasm have gone into the welding of cast iron with the oxy-acetylene process. The only visible complication with the latter system was the problem of expansion and contraction, especially on cylinders or boiler sections. Those who were sufficiently interested and ambitious have learned how to overcome this complication, and we have seen some of the largest cast iron cylinders preheated and welded successfully. This welding was a decided improvement as compared with the old time bronze patches, or brazing methods and such operations have saved millions of dollars to railroads and industrial plants.

Nevertheless, one of the oxy-acetylene companies have recently introduced again the old time brazing process, recommending it on locomotive cylinders. There is an old time saying that when we get old, we are going backwards, or become like children. Is the oxy-acetylene welding process really so old that it has to go backwards and abolish the real cast iron welding process on locomotive cylinders and go back to a substitute of the former brazing process? I recently saw a demonstrator advising an old railroad machinist welder how to braze a broken locomotive cylinder. In the discussion I had with the demonstrator he claimed that the brazing on that cylinder was a model job.

A year ago one of my demonstrators advised me that he could weld cast iron with the electric machine. I did not pay any attention then, as I believed that the only way to weld cast iron was to preheat same and weld it with the oxy-acetylene torch. However, this man has made the same statement to an official of one of the railroad companies, and he took him at his word and let him weld two large locomotive cylinders that were broken on the steam pipe

Fig. 2. Showing Hole Cut in Cylinder to Permit Access to Interior.

in the cylinder saddle. This was not a fair test of my demonstrator's ability to weld cast iron cylinders without preheating and make a job that would stand 185 lb. cold water pressure, because the same job could not be welded with either the old time brazing process or with the oxy-acetylene flame; nor could it be patched with patch bolts. Yet this man undertook the job and showed me that cast iron cylinders can be welded with the metallic arc., without preheating doing overhead welding on a job which I would not have undertaken under any consideration. Furthermore, the weld was machineable and absolutely tight.

The above work was done on Engine 671 for the M. K. & T. Railroad. The officials are very enthusiastic about it. This work was done at Shreveport, La., and has saved two locomotive cylinders from going to the scrap pile and sixty

Welded Pressure Vessels

For several years efforts have been made to draw up a Code for the Welding of Unfired Pressure Vessels. Opinions of the best welding experts were not in agreement on many essential points. Fundamental scientific knowledge based on test data was not available. The American Bureau of Welding has completed a series of tests on some 47 tanks. The program involved an expenditure of over $15,000. The test data, analysis of same, conclusions and recommendations to the Boiler Code Committee of the A. S. M. E. has been compiled in a report, copies of which are available for distribution at $1.50 to members and $5.00 to non-members.

American Welding Society

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days time of waiting for two new cylinders. This work was done at the W. K. Henderson Iron Work's shops at Shreveport under the supervision of Mr. C. F. McHenry, Shop Supt. With our demonstrator's practical ability and with Mr. McHenry's mechanical ability, the electric welding device was untilized to its full benefit, and a good many operations were performed which would not be considered by other shop superintendents.

Manufacturers of electric welding machines are discouraging the welding of cast iron with the electric arc. The majority of men employed in electric welding claim that cast iron welding with the electric process is no good and I shared their opinion. However, since then, I have changed my mind and I do belive that cast iron, especially cylinders, can be

Fig. 3. Arc Weld on Cast Iron Engine Bed.

welded electrically. There are two methods which in most cases are employed:

FIRST. The graphite electro which in most cases is similar to oxy-acetylene process and which requires preheating. The only advantage to be gained with the graphite electric welding over the gas flame, is that it does not set up as much thermal disturbance in the vicinity of the weld.

SECOND: The metallic arc which uses bare wire, or electrodes. The end of the electrode (rod) is brought in contact with the job to be welded and an arc is formed, which has the effect of fusing the electrode, which at the same time penetrates into the job. The molten metal flows out from the end of the electrode on to the work until the entire electrode is consumed. A given distance can be maintained between the fusing end of the electrode and the work. The uniformity of this distance depends greatly upon the experience of the operator. This method was employed in the welding of the two cylinders shown in Fig. 1 and Fig. 2.

Fig. 1 and Fig. 2 shows the steam pipe in the cylinder saddle welded at the white marks These pipes are solidly cast with the cylinder, steam passing through them and through the portholes into the cylinder. As shown in Fig. 1 and Fig. 2 a hole was cut out with the carbon arc on each cylinder, so as to be able to work on the internal steam pipe.

The breaks, being internal, we had to cut out with the carbon arc on each cylinder a patch large enough so as to be able to reach all around the steam pipe. We used a motor generator single operator set, set at 200 amp—45 volts. We welded the top break first, in alternating spots, using a special iron nickle electrode in building up the "V" shape on both sides about ¼" thick, and finished the welding, also, on alternating spots in the center of the "V". The bottom break was performed the same way on each steam pipe of cylinder.

We then tested the welds with 185 pounds cold water pressure and found the welds tight and satisfactory. Our next operation was to build up the outside support holes, which were previously cut out, so as to be able to weld the internal steam pipe. This space does not contain any pressure and it merely acts as a support in the structure of the cylinder. We used as patches a steel plate and welded them in with ordinary electrodes as used for boiler welding.

Figure 1 and Figure 2 show only the building up of the special metal on bevel of cylinder, but does not show the steel plate patches finished. Another wide awake welder in Shreveport, who witnessed this operation of the two cylinders, and who was an old efficient oxy-acetylene welder contracted at that time to weld large engine bed frame, weighing about ten tons, for a refrigerating company in Shreveport, and he used the electric arc process, and made a successful job without preheating.

He also had a gasoline engine driven unit—This unit is better adapted for commercial welders, because they can do eletric welding anywhere regardless of whether electric current is available. This engine bed was broken completely all around and required nine feet and 10 inches of welding. Actual welding was about forty hours and it required about 165 pounds of filler rod to complete the job.

Fig. 3 shows the weld completed with a liberal reinforcement. The method of welding was followed in the same order as outlined in the cylinder welding, and the operator shown with shield in his hand, did the work. This man is an old and efficient welder. It was remarkable to see how quickly he grasped the technique of this process, and did a real good job on the engine bed. His only experience was to observe our demonstrator's operation on the two cylinders and secure a few pointers from the same man.

TRADE ASSOCIATION ACTIVITIES THAT HELP

Declaring that the trade association as a facility for the promotion and self-regulation of industry and commerce has become, by reason of its scope and activity, an important American business institution, with which the public, generally speaking, is little acquainted, Herbert Hoover, Secretary of Commerce, in the introduction to the Department's new book entitled "Trade Association Activities" released July 16th, expressed the opinion that the constructive purposes of these organizations have unfortunately been confused with the minority of activities, which have been used as a cloak for action against public interest.

"Just as a business house or an individual meets its obligations and carries on its daily relations within the community, so the trade association has a real individuality in the business fabric," according to Secretary Hoover.

"All trade association activities are not good, just as all individual habits are not good until so proved by their reactions on the individual and the community," the Secretary says, adding that "perhaps the best way to guide activities into the most constructive and profitable channels is through thoroughgoing analysis and examination of those activities which seem on the surface to be constructive in their application and results."

Waste elimination, in a vast area of problems, can only be accomplished by collective action in a trade. Hundreds of millions of dollars have been saved through the adoption of principles laid down in such programs, not alone to the business groups concerned, but to the ultimate consumer. They have brought about lower prices, through attacking directly the costs of raw material, inefficient plant operation, and unnecessary stock maintenance.

Credit and collection activities, trade disputes and ethics, insurance, public relations, traffic and transportation, commercial research, industrial research and government relations are among the other subjects discussed by Secretary Hoover in the introduction to the book, a volume of 368 pages, sold by the Superintendent of Documents, Government Printing Office, Washington, D. C., and by the field officers of the Department of Commerce at fifty cents (50c) a copy.

WELDING AS A BUSINESS FACTOR*

The Business Man's Interest in the Oxy-Acetylene Process—Use of the Torch for Fabricating Metal Parts—Welding in Tank Construction

By G. O. Carter†

THE technical applications of the oxy-acetylene process have been very thoroughly discussed over a period of many years, so among technical men the processes of cutting iron and steel and the welding of practically all metals are fairly thoroughly understood. The oxy-acetylene process as a general business factor is, however, a question which has not been discussed anything like as much in the past as will be the case in the future.

Business men should always be interested in those things which effect economies and which enable them to make other or better products. This has been over a period of several years, a large part of the study of the company which I represent and the following facts are taken from our experience in service work in hundreds of places, from the largest to the very small ones.

As a time-saver, the oxy-acetylene cutting torch is fairly well known, particularly where buildings are to be dismantled, boilers and heavy machinery to be cut up or in the punching of rivet holes where they would otherwise have to be drilled, because in work of this sort the torch has been a very great labor-saver and has, therefore, become popular with the operating men.

Another place where the oxy-acetylene cutting process has been a time-saver has been in the dismantling of machinery for effecting repairs. For instance, where a machine has a value of many hundreds of dollars an hour, or even a matter of tens of dollars per hour, the saving effected by reducing the interval for shutdowns runs into real money; therefore using a torch to remove the nut on a holding-down bolt in a matter of seconds where removal by sledging or a wrench might often require hours is so logical that once learned, the lesson need seldom be repeated. In some of the very big mills of the country, the machinery is rated as being worth one thousahd to fifteen hundred dollars per hour, and one often hears stories of how it formerly took as high as 12 or 18 hours to unscrew a frozen nut. This does not include the time for effecting the entire repair. At present, in mills of this class, machinery is dismantled in well under an hour from the time the breakdown occurs, new parts are substituted and the machinery is operating anywhere from 3 to 5 hours after.

It is quite obvious to the business man that an emergency oxy-acetylene cutting outfit should be kept handy by the master mechanic of a factory, and if only used once or twice in the course of a year the company will be well repaid for the investment. Emergency apparatus need not be always kept at one place, as is fire apparatus, if an operator is always immediately available to go on emergency work. The principle of having an outfit quickly available is the major thing, its location is a matter for internal arrangements within any plant.

Of course the oxy-acetylene outfit is very valuable in accident cases where steel beams may be pinning down an injured person, such as in an elevator, the collapse of a building or entanglement in machinery.

The use of the oxy-acetylene cutting process in day-to-day operations is a matter of increasing importance because by means of the cutting torch, forged steel is shaped much more rapidly than by any other form of machinery. Some interesting examples of the way the cutting torch is used in shaping forgings may be noted in many machine shops such as that of the Erie Forge Company where crankshafts and connecting rods are being cut out daily. The Camden Forge Company in the East is another outstanding example of good practice; many railroad shops cut out side rods and other parts at a cost very much less than the cost for machine rods.

The cost of manufacture of parts is of great interest, but there are many other costs which should be taken into consideration. For instance, in railroad shops where it formerly took at least seven days to machine a side rod, a large stock of rods had to always be kept on hand for each type of locomotive. Where the oxy-acetylene process is being used and a locomotive comes in with a broken rod, the new rod can be cut from a forging in half a day and can be ground, where necessary, for further finishing and be ready for installation within a day. There are always enough minor repairs about a locomotive to warrant a day in the shop when brought in for an important repair, like to a side rod, therefore by using the oxy-acetylene cutting process and having a small stock of slabs or forgings from which to produce the rods, railroad companies can entirely do away with the expense of keeping a big stock of finished parts.

This kind of thing has made quite a definite impression on many business men in numerous industries, and I am sure that all those present can see that the possibilities for constructive use of the oxy-acetylene cutting torch will warrant a careful study in every plant of the country. Needless to say, the cutting of iron and steel is being given most careful study by the companies specializing in the oxy-acetylene processes, and you can undoubtedly benefit by calling in the engineers of such companies to learn of the possibilities in your own work.

The above should not indicate that Cincinnatans have not been going into this matter but is intended as a problem for all business men of the country. As a matter of record manufacturers of Cincinnati have been using the cutting torch in very interesting constructive work and are undoubtedly obtaining as good results as in any section of the country. The growth of the oxy-acetylene industry, however, will carry this constructive work into practically every machine shop, foundry and steel mill in the country, which is not now the case by a good deal.

.The possibilities of oxy-acetylene welding are as interesting and valuable as those of the cutting process. Welding in the past year or two has made some very impressive strides. For instance, at a convention last Fall in Chicago, many of those who attended the convention were astonished at the progress being made in the oxy-acetylene welding of steel pipe as exemplified by two papers—one by the Welding Superintendent of the Prairie Pipe Line Company, which is a well-known transporter of crude oil from Oklahoma and Texas to Chicago and St. Louis; the other paper by an engineer of the Western United Gas & Electric Company, which company manufactures its gas at a big central plant in Joliet, Ill., and passes the gas under seventy pounds pressure to one hundred or more cities, including such centers as Aurora and Elgin. The total extent of this company's installation runs into hundreds of miles, and since about 1914, the oxy-acetylene welded joint has been standard with them.

In another part of the United States, a municipal gas company has over 1,000 miles of welded pipe in the ground and has used no other form of construction in practically ten years.

For steam lines oxy-acetylene welding undoubtedly gives the tightest joint and the most economical for good construction. At the present time there are quite a few very excellent welded steam lines which have been put in by big concerns after thorough investigations of the possibilities, and the companies specializing in industrial piping are using the oxy-acetylene welding process regularly in making headers with what are technically called "neck welds."

**Paper read before Purchasing Agents' Association of Cincinnati, Ohio.*

†Linde Air Products Co.

In past work we have, of course, met with inquiries as to the reliability of welded pipe installations and that naturally brings up the matter of a test. We have for several years been following what is called the "pressure-impact" test and have satisfied ourselves that, when properly applied, practically no trouble ever develops in an oxy-acetylene welded installation. In the case of steam where escaping would be very serious, we recommend that a hydrostatic pressure of three times the working pressure be applied to the line and, while under pressure, that every joint be hammered or hit with a sledge. Several 300-pound steam lines have, to my knowledge, been tested to 1,000 pounds water pressure and given a hammer test, and I do not believe that any engineer can feel that a line is apt to give trouble when he knows that it has passed as exacting a test as that. For other types of lines, such as city gas lines and oil lines, the test pressure does not necessarily need to be as high as for steam because the lines will not be subjected to the difference in temperatures that steam lines must stand. Oil and gas, however, are a source of considerable hazard if they escape, so a test pressure of double or two and one-half times the working pressure is probably desirable. With air and water lines a test pressure of one and one-half to two times the working pressure should be ample, although with a properly designed line there is no reason why higher tests should not be applied if an engineer so desires.

Business men should be interested in the reduction of losses by welded steam lines, both on account of elimination of leaks at flanges as well as the better insulation of pipe without flanges. A recent paper about heat losses in pipe lines showed conclusively that where the pipe itself is covered with the usual lagging but where the flanges are exposed, the heat losses are half that experienced where bare pipe and bare flanges are used.

If the flanges are protected with insulating material, it is always an expensive matter to take the insulation off to get at the flanges for tightening up, which must be done at frequent intervals. Just as an incidental matter in regard to the major savings to be effected by the use of a welded installation, I have been advised that the direct cost of oxy-acetylene welded joints is only about 20% that of the Van Stone flange, which has been the usual method of joining high pressure steam pipe. This does not mean that the over-all cost will be 20% as pipe costs, handling costs, etc., will be approximately the same in both cases.

In oil, air and gas lines, the use of the oxy-acetylene welded joint saves leakage and leakage is usually a matter not only of the loss of the contents of the pipe, but where leaks occur there is almost always some damage or expense involved in overcoming the leakage. In municipal gas lines the leakage is a very important matter, and in long lines leakage is somewhere around 25% to 50% of the total volume of gas where ordinary forms of construction are used. The leakage through a properly welded joint is nil.

Where leakage of gas, oil and water occur, damage usually involves considerable "write-off" for damaged goods or expense for lawsuits, or as compensation for damage to property. All of these are business men's problems and I find that oxy-acetylene welding is getting much more attention since it has been demonstrated that welded lines practically eliminate all the troubles from leakage. Time which business men now must devote to annoying details like the settlement of claims or for investigating the losses due to leaks can certainly be much better applied to other problems which are constructive and, therefore, the saving in time to the business man is a considerable item.

Among the technical possibilities in pipe work from the use of the welded joint is the use of high pressures for transmitting oil, gas, air, etc. There is really no reason why pressures several times as high as are now being used in many places should not be carried by welded lines. This would be comparable to high voltage transmission of electrical current. If the transmitting power of an installation is materially increased, the capital investment per unit transmitted would be reduced. This again is a problem for the business man.

The welding process is also being used in the construction of tanks of all kinds from pressure vessels for carrying 200 or 300 pounds of pressure of such gases as ammonia, which is very difficult to hold in any other type of vessel, down to the lubricating oil tanks, gasoline storage tanks, etc., which are in the ground all over the country and in every factory. Cincinnati has at least one tank manufacturer with a national reputation for making oxy-acetylene welded gasoline tanks for tank wagons, where the vibration and bumping of the tank is certainly as severe a test as can be well applied. Incidentally the welded tanks on these wagons are showing up to such good advantage that practically no other type of construction is now in use.

From a business man's point of view the welded tank situation gets back to about this: Many types of tanks are on the market, and where the cost alone is considered, some other forms of tank may be slightly cheaper, although as a general thing the oxy-acetylene welded tank is as cheap as a rivetted one.

Where, however, the use of the tank is given first consideration and welding is specified, the purchaser gets the best construction and the tank manufacturer is automatically forced to consider a better product.

There are a good many tank manufacturers who have been backward about welding because they have been able to get a certain amount of business by quoting lower prices for rivetted construction than their competitors did for the welded work. When welded construction is specified by purchasers, practically all tank makers will come to the use of welding in order to get a chance at the business. From watching the growth of welding over a period of years, it is my belief that welding of tanks will be the rule in a very short time.

As an interesting growth in the welding of tanks I call your attention to the welded construction of two 1,000 barrel oil storage tanks which are now being observed very carefully under service conditions. There seems to be no reason why any difficulty should be experienced with these tanks, and if after a few more months service this is clearly demonstrated, more tanks of this type will undoubtedly be built. The use of welded tanks should reduce the fire hazard because there should be no oil leakage such as occurs with most rivetted tanks after being placed in service.

I am not going to say a great deal about the welding of these tanks, the size being 20 feet diameter by 18 feet high, or even larger ones which we expect soon to weld, because we encountered quite a little difficulty in the construction of these first two tanks and it may be that we will continue to encounter some difficulties. The difficulties were not, however, with regard to strength or tightness but were with regard to handling the sheet metal and are largely a matter of appearance. After the completion of the tanks, we spent several days in straightening them and succeeded in removing practically all the buckles, particularly in the second tank.

From a business man's point of view I think that the welding of fairly large storage tanks is going to be of a good deal of importance because it will reduce the losses by leakage, it will save considerable on maintenance due to the continued repainting of tanks which leak, and will probably prolong the life of tanks because, when corrosion has occurred around the laps and rivets, the tank has to be replaced.

The same effect of corrosion at laps and rivets applies to steel smokestacks where it is quite apparent that welded construction is as good as or better than rivetted construction. One manufacturer of smokestacks recently advised a representative of our industry that his company did not go in for the welding of stacks because stacks now lasted plenty long enough, the life of a rivetted steel stack being five to eight years, whereas the life of a welded stack would undoubtedly be double that. In my opinion, the attitude of the stack manufacturer was rather shortsighted, but it is the attitude taken by many of us toward improved methods.

The welding process has been used for many years and in practically all plants for maintenance work. A broken casting

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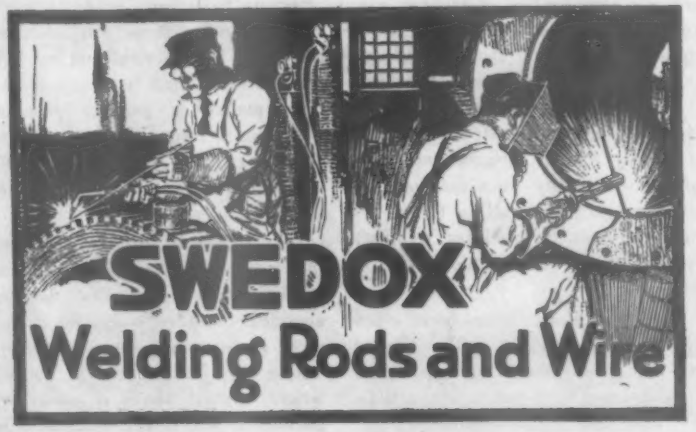

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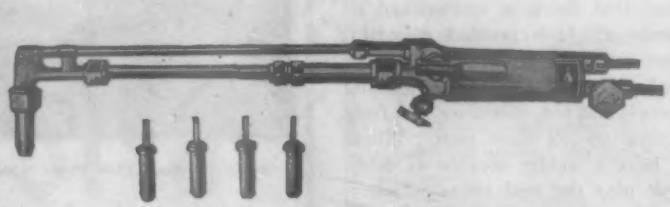

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or a broken part of almost any casting can be repaired by the welding process so as to be entirely serviceable. Cast-iron can certainly be welded under proper conditions so as to give a joint fully as strong as the original section, and if the breakage has been due to a defect in design, the part can be readily reinforced. The same thing applies to the welding of steel castings, but in the welding of rolled or forged steel, the oxy-acetylene weld will not be as strong as the original material unless the deposited metal is of higher quality than that originally used. Where fairly low-carbon steel material is to be repaired nickel steel or special alloy rods can be used for welding, and if slight reinforcing is possible, the welded section will be fully as strong as the base material.

Wherever possible, welding should be done from both sides in what is called the "double V" construction. This saves considerably in the amount of deposited metal and from an engineering point of view, the welds are very much better than when a weld is made from one side only.

For maintenance welding, the best practice seems to be for a plant to have a central welding shop as a part of the master mechanics' organization just as is the machine shop. By having the proper facilities, such as preheating ovens, an air supply for an air chisel if the plant is equipped with air, grinders, etc., the time of making repairs by welding is materially reduced and the quality is much improved over that which is usually obtained if repairs are undertaken where the material is installed.

Practically all of the metals can be economically repaired at the present time. This includes copper, aluminum, malleable iron, as well as steel or cast-iron. The technical procedure to be followed is not the same for all the different metals, however, and if an operator is not experienced on any given class of work, experienced service men should be called in to help. The organization which I represent is doing a great deal of this kind of work with its customers and the industry has certainly benefitted in the past several years through this service work.

I have reserved until the last what is probably the most important of all the problems for the business man to consider and that is the personnel question. Oxy-acetylene welding should be considered as a skilled occupation, and welders should be thoroughly tested to make sure that they are capable of executing high quality welds. Their work should also be tested whenever possible just as is the work of any other artisan.

An oxy-acetylene welded test piece can be put in a vise and hammered until it bends or breaks, when an examination of the fracture will show just what the welder is doing. A good welder should be capable of making the flame penetrate to the bottom of the veed-out section, which is necessary in joining parts by the oxy-acetylene welding process; he should also get thorough fusion of the metal on both sides of the joint and his weld metal should be free of blowholes and inclusions.

There are many places in this country where the say-so of an applicant is accepted as proof that he is a welder and no steps are taken to make him prove it. It is probable that this is due to the fact that master mechanics and maintenance engineers of most plants received their training before welding became an important part of the work and are, therefore, not fully familiar with the ways of checking up on these men. Where one learns that a plant does not have a welder because of doubt of the process, it is time to look into the real cause which is quite often a feeling of inability to judge if a welder is capable or not. Quite often too, plants which do not use welding have had past experiences where the welders themselves were incompetent and, therefore, the whole welding process was discredited. The industry has passed the stage where the process can be discredited by the failures of individuals.

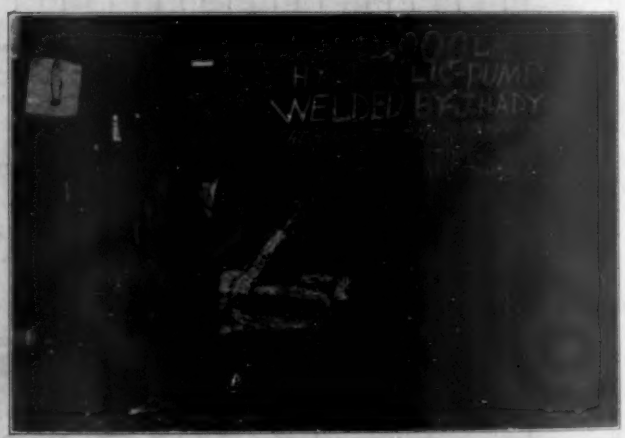
Oxy-acetylene welders should undoubtedly be paid by a method which has been found satisfactory in any given plant for paying such skilled men as the machinists, who are on general repair work; or if the welders are on production work the payment should be based on that found desirable for other types of construction work in the same plant. In a good many places attempts have been made to use unskilled or semi-skilled men as welders, and generally it costs more in the long run than if the men had been considered as skilled men in the first place and then a study had been given to reducing costs by other means. The quality of product produced in oxy-acetylene welding is by far the most important matter and, as compared with other types of joints, the quality of the oxy-acetylene weld should be considered and sold rather than trying to reduce competition to a strictly cost matter.

Oxy-acetylene cutting is an easier thing to learn than welding, because cutting is a simple machine tool application, whereas welding requires a great deal of knack and experience. Oxy-acetylene cutters can, therefore, be considered as semi-skilled men, if just on general work, or can be considered skilled men where they are on repeat operations as in foundries. In places where oxy-acetylene is used constructively in cutting, as noted earlier in the discussion, they would undoubtedly be considered as skilled men.

The personnel situation with regard to both oxy-acetylene welders and cutters should, therefore, be handled very much as is the personnel question in general. It should neither swing to the extreme of a company putting all of its faith and reliance in its welder, and neither should a company hesitate to go in for the process because there seems to be some difficulty in finding good men. If conditions are right, a company can get competent men and keep them up to scratch in their work and that is undoubtedly what we should all be interested in.

DIFFICULT WELD ON HYRAULIC PUMP CASTING

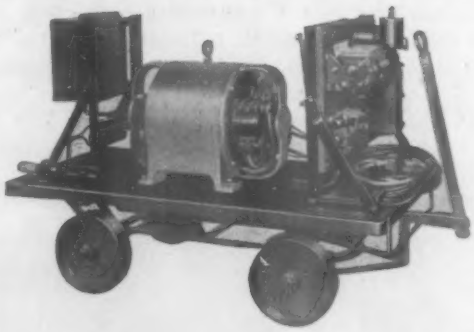
The accompanying photograph shows a two thousand pound cast iron hydraulic pump which was recently welded for the New Tread Tire Company, of East Palestine, Ohio, by J. H. Andy, proprietor of the Guarantee Welding Works, of that city. The arrows in the photograph indicate the place where the worst part of the break occurred. Unfortunately the broken piece was lost so that it was necessary to fill in an entirely new piece with a welding rod. There was also a flange to be welded on. A charcoal fire was used to give the casting a general preheating before the welding was started, and after the weld was made it was completely covered with ashes so as to let it cool as slowly as possible. This part of the job was done so carefully that after thirty-six hours, the casting was still a little warm. Then it was taken out of the ashes and the flanged part was dressed down with a large file. After the pump was assembled, it was tested by turning on about three hundred pounds pressure. Not a single leak developed. The job is a good illustration of how a weld can be made right the first time if proper precautions are taken from the time the job is started until it has cooled.

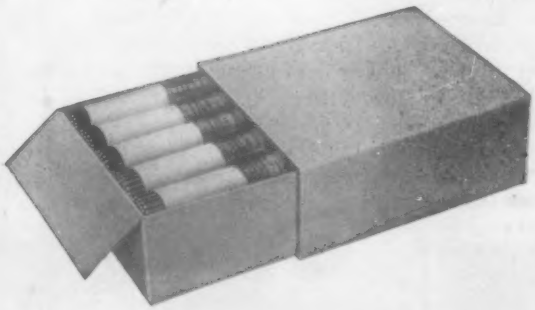


After Welding This Piece Was Given Thirty-Six Hours to Cool.

FOR ARC WELDING

Cast Iron
Malleable Iron
Steel
Brass
Bronze
Monel Metal





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With the co-operation that we supply from this end you can easily make good profits on spare moments. We'll supply an agent's outfit that's complete, easy to tuck into your portfolio, and helpful.

Write us today.

The Welding Engineer
608 S. Dearborn St. Chicago

G. P. A. MEMBERS ENJOY RECORD CONVENTION AT EXCELIOR SPRINGS

The annual mid-summer convention of the Gas Products Association which was held at Excelsior Springs from June 26th to June 28th not only set a new record for attendance, but furnished a week of pleasant association and inspiring business meetings to those who were present.

At the opening session, which was held on Tuesday morning, Mr. M. L. Goodrich, president of the Association, presented a report which promised continued progress and benefits from the harmonious relations which have been established in the industry by the members. By a careful analysis of the present business situation, he indicated the good prospects for a healthy volume of trade in 1924, as well as for the remaining months of 1923.

Mr. Goodrich then outlined the present situation of the Association in regards to membership, possibilities of further expansion, and followed with the very interesting discussion of present and future activities. The work which it is proposed to carry on in future months is to a large extent devoted to the business end of gas producing plants, but there are also in contemplation a number of activities along educational lines from which the gas welding industry will certainly derive direct benefits.

Gas Products Association Convention at Excelsior Springs, Mo. The Meeting Was a Big Success.

In addition to Committee Reports and Officers Reports, the program of the meeting included the following addresses:

"Liquefaction Plant Operation," by E. G. Luening.

"Co-operative Advertising to Increase Gas Welding", by Wm. Clendenin.

"Commercial Uses of Hydrogen," by John P. Harris.

"The Amortization of War Facilities," by Theo S. Cady.

During the three days of the convention there was an interesting golf tournament in progress. Practically everyone in attendance at the convention participated.

The first prize was won by J. R. Brand. Second prize by Mr. G. E. Holbrook, and the booby prize by C. T. Price.

The following officers and directors were elected for the coming year:

President, M. L. Goodrich; 1st Vive President, E. A. Faulhaber; 2nd Vice President, C. O. Epperson; Directors: E. H. Smith, O. E. Engler, H. J. Muller, J. R. Brandt, J. R. Foran, F. B. Wilkinson, E. D. Findlay, A. J. Russell.

The following concerns were elected associate members:

K-G Welding & Cutting Co., New York City; St. Paul Welding & Mfg. Co., St. Paul, Minn.; U. S. Gauge Co., New York City; United States Welding Co., Minneapolis, Minn.; United LeLad Company, New York City; Innis, Speiden Co., Chicago, Ill.

Those present at the convention were:

E. D. Findlay, President Acme Oxygen Co.; G. M. Holbook, Mgr. Oxygen Dept. Armour & Co.; C. M. Moody, Secretary Auto-Lite Gas Co.; Mr. J. B. Beaird, The Bain-Beaird Co.; O. E. Engler, Secretary The Belbach Co.; A. G. Russell, Vice Pres. The Bettendorf Oxygen Hydrogen Co.; H. B. Pearson, Vice Pres. Burdett Oxygen Co.; J. B. Burdett, President Burdett Mfg. Co.; R. J. Lozon, Sales Mgr. Burdett Mfg. Co.; E. A. Faulhaber, President Burdett Oxygen Co. of Detroit; C. O. Epperson, President California Compressed Gas Co.; C. J. Haines, Gen. Mgr. Electrox Co.; J. R. Brandt, Vice Pres. Indiana Oxygen Co.; A. A. Heller, Treas. and Gen. Mgr. Internation Oxygen Co.; J. R. Foran, Pres. Kansas City Oxygen Gas Co.; P. B. Francis, Secy. Kansas City Oxygen Gas Co.; H. H. Sims, President Memphis Oxygen Co.; H. N. Smith, Sec-Treas. Memphis Oxygen Co.; A. S. Bordeaux, Vice Pres. Michigan Ox-Hydric Co.; W. F. Verkamp, Manager Ohio Electrolytic Oxygen Co.; M. L. Goodrich, Manager Oxygen Dept. Swift & Company; Williard Foster, President Tulsa Oxy-Hydro Co.; H. G. Austin, President National Oxygen Co.

ASSOCIATE MEMBERS:

Herman G. Amling; E. L. Mills, Sales Manager Bastian Blessing Co.; M. Keith Dunham; Wm. S. Noyes, Vice Pres. Imperial Brass Mfg. Co.; Mr. C. Brownson, Innis, Speiden & Co.; C. E. Phillips, District Manager The Purox Company; H. G. Landberg, Asst. Sales Mgr. St. Paul Welding & Mfg. Co.; L. B. Mackenzie, President *The Welding Engineer*; Chas. L. Gulick, Manager Cylinder Sales, Wm. Wharton, Jr. & Co.; Mr. Carlson, Works Mgr., Wm. Wharton, Jr. & Co.; C. R. Pollard, Sales Manager Milburn, Alexander Co.; Messrs. A. J. and T. F. Fausek, Modern Engineering Co.

HONORARY MEMBERS:

Mr. E. G. Luening.

VISITORS

Mr. Theo. S. Cady, Federal Tax Expert, Fidelity National Bank & Trust Co., Kansas City, Mo.; Mr. John P. Harris, Chemical Engineer, Kansas City, Mo. Underwriters' Laboratories; Mr. Chas. R. D'Olive, Compressed Gas Manufacturers Association; John Hays, Secy. Conover-Mooney Advertising

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"RACO" Covered Electrodes are used with either alternating or direct current where bare wires will not give satisfactory results.

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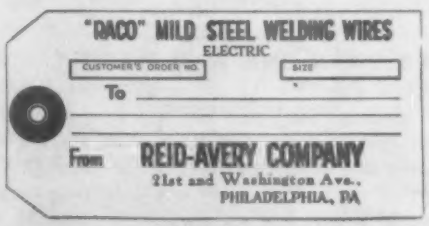
This wire may be used with success wherever imported Norwegian or Swedish wire has been considered necessary.

"RACO" MILD STEEL RODS FOR OXY-ACETYLENE WELDING
Copper Coated

Answers the usual railroad, shipyard and industrial requirements as are allowed by authoritative regulating bodies such as the American Bureau of Shipping, the Interstate Commerce Commission, etc.



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OXYGEN PLANTS

We have sold TWENTY-FIVE Liquefaction Oxygen Plants during the past eighteen months. Some of the reasons why our plants are so heartily endorsed by the oxygen industry are as follows:

RELIABILITY: Most of our customers are companies whose business existence depends upon their ability to furnish a reliable and constant supply of 99% pure oxygen. Our liquefaction plants have demonstrated their dependability in this respect.

ECONOMY: The cost of producing oxygen is reduced by the liquefaction process to an absolute minimum. The saving in power cost alone has been sufficient to make some of our plants pay for themselves within a year.

FLEXIBILITY: The guaranteed capacity of one of our plants is 1050 cubic feet of oxygen per hour. Due to the short starting period required, a plant can be operated economically, so as to meet daily oxygen demands ranging from 10,000 to 25,000 cubic feet.

COMPACTNESS: A complete production plant can be installed in a room 25′x 28′, or in less than 700 square feet of floor space. A suitable installation can be made in practically any type of building where such space is available.

SIMPLICITY: Only one man per shift is required to operate the entire production unit. An ordinarily intelligent man who never saw an oxygen plant before can become a competent operator after a few days of instruction.

SERVICE: We install the entire production plant and turn it over to the purchaser complete in every detail. We maintain a competent service engineering department and a complete stock of all repair parts which are instantly available to our customers. Our plants are backed by responsible guarantees.

You are welcome at any time to inspect our demonstration plant at Chicago.

M. KEITH DUNHAM
110 South Dearborn Street
Chicago, Ill.

Co., Mr. R. J. Mooney, President; Mr. William Clendenin, Trade Association Advertising.

A highly interesting feature of the program was the adoption of a Code of Ethics or standards of correct practices by the Association. This copy covers the relation of employer and employe—relation with those from whom purchases are made—relation with other members—relation with the general public and the government—relation with customers and prospective customers in making and executing of contracts, and the obligation to observe the standards as set forth under these different heads.

Foster, of Tulsa, Oklahoma, Is Noted for His Habit of Gathering About Him About All the Desirables in Sight. This Picture Shows Him Batting 500.

TANK WELDING

(Continued from page 29)

easily confine the burned part to a considerably smaller area, thus eliminating any possible objection to welding them by the oxy-acetylene process. The welded sections should be finished with a coating of aluminum paint, shellac or other suitable material in addition to being water-proofed. When this is done satisfactory results are assured.

Some of the largest tank manufacturers in the country are building quantities of galvanized iron all oxy-acetylene welded gasoline and oil storage-tanks, and in their years of experience they have never encountered an oxy-acetylene welded tank that leaked while in service, either in the weld or in the base material adjacent to the weld. The film of oxide on the outside of an oxy-acetylene weld is an excellent protection to the weld metal under it.

Examples of Tank Welding

To illustrate the methods and practices described the following examples of tank welding are given. Each is representative of a type of tank commonly used and variations from the procedures outlined need not be radical when constructing tanks of different size or shape.

A Round Open-Top Tank

The material having been cut, the shell of the tank is formed into a cylinder. If rolls are used it may prove difficult to roll the edges to a perfect circle. They may come out with distorted edges which must be pounded or otherwise bent to conform to the proper circumference of the circle or the finished tank will be off shape and its appearance spoiled. It is beter to have the edges depressed about ⅛ in., as welding will tend to straighten the edge sections to the desired contour. If not, they can easily be pounded or pressed into shape after welding.

Next, the ends should be tack welded at one end and clamped at the opposite end. The seam being 4 ft. long the edges are clamped (⅛ in. for each foot the seam is long) ½ in. apart at the end of the seam opposite the point where the welding begins. It will depend on the speed of the operator whether or not a wedge should be used. If the edges appear to be drawing together too rapidly a wedge should be applied to hold them the proper distance apart and overcome the force of expansion.

Upon completing the side seam (or seams, if two or more are used) if the shell appears to be out of shape the distortion can be removed by pounding the sections affected.

In welding the bottom to the shell the latter is set on end and the bottom sheet is placed in position and supported so that it will not fall into the shell. The seam is first tack welded at about 8 in. intervals so when the welding is begun it can proceed without interruption.

As 12-gauge sheet is only 7/64 in. thick some sort of a stiffening ring, preferably of bent angle iron, should be tack welded to the top edge to protect it from damage and to stiffen the tank.

A Rectangular Open-Top Tank

About 200-gal. capacity and 4 ft. long by 3 ft. wide
Calculations for size:
200 gals. = 26.74 cu. ft.
Area Bottom = 4 ft. × 3 ft. = 12 sq. ft.
26.74 ÷ 12 = 2.23 or 2 ft. 2¾ in. height of tank

The tank will therefore measure 4 ft. long, 3 ft. wide and 2 ft. 2¾ in. high.

Assuming that this tank must withstand hard service 3/16-in. thick sheets will be used. The sides, ends and bottoms are squared off and cut to size with the cutting blowpipe. The cut edges are then cleaned with a rasp or wire brush and the material is ready for welding. The sheet for the whole tank is tack welded together at one time. After this is done the bottom seams are welded and then the side seam beginning at the bottom and welding up. Had it been necessary or economical to weld small sections of sheets together to form the sheet for the sides or bottom the utility or strength of the tank would not have been impaired.

If desirable to reinforce the sides this can be done by tack welding bar or angle iron strips around the top edges. Often times it is permissible to stiffen the sides of a rectangular tank with tie rods.

In all cases where tanks of these two types are to be raised above the floor or ground it is more economical to build a platform or base with a solid top for the tanks to rest upon than it would be to reinforce the bottoms of the tanks.

A Round Horizontal Storage Tank

500-gal. capacity, 8 ft. long
Calculations for size:
500 gals. = 66.85 cu. ft.
66.85 ÷ 8 = 8.6 area of ends
= 10.4 circumference of ends
= 3 ft. 3¼ in. diameter of ends

Size of tank, therefore, to be 3 ft. 3¼ in. diameter and 8 ft. long.

The sheets having been rolled mechanically or as described for the round open-top tanks, the longitudinal seams of three sections are welded. The width of the shell sections is arbitrary and may be whatever width is best suited to the material on hand or obtainable. The longitudinal seams having been welded, the next step is to join the circumferential seams.

MORE THAN ONE WAY TO KILL A CAT

Not long ago a publication whose editor was evidently not a well posted welding "fan" paid not less than a dollar to a contributor who furnished the suggestion that when a welding rod was laid down the welder should twist a piece of wire around the cool end of the rod so there would be no danger of burnt fingers when it was picked up again. A practical welder was asked if he could furnish a suggestion which would get the same protection with less effort. "Sure," he replied, "Just teach the welder to spit."

The Westinghouse Electric & Manufacturing Company has issued the first number of a minature publication entitled, "Electric Heat." This publication will be published frequently is devoted to industrial electric heating problems. In this issue there are articles concerning the use of electric heat in the manufacture of storage batteries, electric motors and many other subjects. Of special importance are articles by Professor W. Trinks of the Carnegie Institute of Technology on "Advantages and Limitations of Electric Heat" and "Reduced Labor—A By-Product," by M. R. Armstrong. The method of calculating power requirements of electric ovens is given together with a number of ways in which hard jobs may be made easy by electric heating.

NEWS OF THE WELDING TRADE

Announcement has been received of the Eighth International Annual Acetylene congress to be held in Paris from the 6th to the 9th of December, this year. It will be called the "Eighth International Congress of Acetylene, Autogenous Welding, and Allied Industries." The Seventh Congress took place in Rome, Italy in 1913, and the program of these expositions was interrupted by the World War. The firms who are interested in carbide, acetylene, oxygen and welding are invited to come to Paris and are assured a hearty welcome at the Congress. Those who are not able to attend have been invited to send their names for registration, which will entitle them to receive the account of the proceedings. The rate of subscription is twenty-five franks. Full particulars can be obtained by applying to the General Secretary, 104 Boulevard De Clichy, Paris.

N. A. Strand & Company, manufacturers of Flexible Shaft Grinding Machines, recently moved from 625 W. Jackson Blvd. to 5001 N. Lincoln St., Chicago.

It is reported that the former Jersey City plant of the Davis-Bournonville has been sold to a number of industrial industries, and is soon to be vacated.

The Davis Welding & Mfg. Company has installed new equipment in its new buiding at 1110 Richmond St., Cincinnati, where the chassis business will be handled while the tank manufacturing plant will be continued at its present location on Queen City Ave. The Davis company makes a specialty of rebuilding old welded oil tank wagons in addition to its general welding repair business.

Savannah, Georgia, is soon to have a new oxygen producing plant, as the Linde Air Products Company, of New York City, has recently awarded a contract for the erection of a Plant at Stiles Avenue and Gwinnett St.

The Memphis Oxygen Company, of Memphis, Tenn., was recently incorporated with a capital stock of $75,000.00 for the manufacture of oxygen.

The Purox Company recently opened a new sales office in Kansas City. Mr. Jack Pettis is in charge.

C. W. Rambo, formerly manager of the Economy Welding Machine Company, has been appointed Kansas City representative for the Carbic Mfg. Co., Duluth, Minn. Headquarters of this branch will be at 411 St. Louis Ave.

A new welding shop known as the Guarantee Welding Works has been opened at 540 E. Martin St., East Palestine, Ohio, by J. H. Ady. Mr. Ady, who is a member of the American Welding Society, has been a welder for a good many years and states that business has been very good.

The Interstate Oxygen Association, of Wheeling, W. Va., has recently joined the Gas Products Association as an active member.

Mr. Calvin L. Jones, Welding Engineer of the Westinhouse Electric & Manufacturing Company, Atlanta, Georgia, has been elected Vice President of the American Welding Society. Mr. Jones has been elected for a two year term and will be in charge of the activities of the Society in the Southern Division.

The Ebright and Luthy welding shop has been opened at 1121 N. Ashland Ave., Chicago, by C. C. Ebright and E. C. Luthy. Mr. Luthy has had many years experience of welding in the United States Navy. Mr. Ebright has represented the K-G Welding & Cutting Co. in Chicago for several years.

Classified Ads

Help Wanted—75c per line, minimum 4 lines.
Jobs Wanted—4 lines free.
Other Ads—$1.00 per line, minimum 4 lines.
Counted 8 words to line. Add 6 words for keyed address.

Position Wanted—Experienced oxy-acetylene welding foreman wants permanent position in job welding shop. Can handle all varieties of repair welding, make estimates, etc. Has long experience as foreman and good record for character and ability. Address 85, care The Welding Engineer.

WANTED— ADDRESS OF H. L. LOVE

Information is wanted regarding the present address of H. L. Love, formerly a welding contractor in Los Angeles, and known to be a specialist in tank and pipe welding. Mr. Love was known to have been on his way east during the latter part of May of this year. Please send information to 86, care The Welding Engineer.

Position Wanted—Managing Engineer for air liquefaction plant desires permanent connection. Manager of the largest oxygen plant in Germany for 15 years. Has built 21 plants. Address H. W. Schultz, 4354 N. Troy St., Chicago, Ill.

Apparatus Salesmen Wanted—We want a man who can take on a first class line of oxygen apparatus and give it good representation, in one of the best territories in the middle west. Address 87, care The Welding Engineer.

FOR SALE—ARC WELDERS

The Department of Street Railways, City of Detroit is offering for sale: Six 2-Arc Wilson Plastic-Arc Gasoline Driven Welders, equipped with two KA-Welding panels, each on skids manufactured by the Wilson Welders and Metals Company of New York City.

This equipment is in first class condition, having been thoroughly overhauled by our own department, and may be inspected at the machinery warehouse, Department of Street Railways, St. Jean and Shoemaker Avenues.

Proposals are solicited for all or any part of the above offering and these may be directed to Geo. J. Finn, Commissioner, Department of Purchases & Supplies, 710 Marquette Building, Detroit, Michigan.

These proposals will have our consideration on Wednesday, July 25th, 1923 at 10:30 A. M., at which time we will answer all communications covering proposals on this equipment.

For Sale—Welding shop. Fifteen years in same location in a manufacturing city of 40,000. We are distributors of oxygen and acetylene and supplies. Must have $2,000 cash. Address 88, care The Welding Engineer.

For Gases Charged at High Pressures
WM. WHARTON, JR. & CO., INC.
30 Church St., New York, N. Y.

A WELDING ROD HOLDER
For the Oxy-Acetylene Welder
If you are selling welders' supplies, keep a few welding rod holders in stock. There is a growing demand for this handy tool.
Write for Prices and Samples.
C. SORENSEN
18 E. 16th Street, Chicago, Ill.

THE WODACK WAY TO BETTER PROFITS

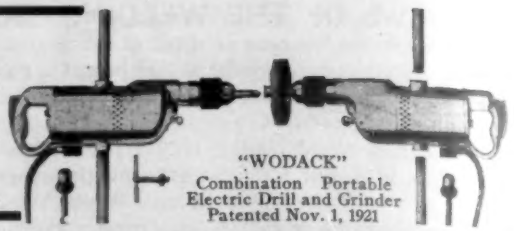
The right finish on a weld, the finish that tickles an extra dollar out of the customers, is just a moment's work with a WODACK Portable Electric Grinder. You can do your drilling with the same tool if you equip your shop with a

WODACK COMBINATION PORTABLE ELECTRIC DRILL AND GRINDER.

Two money-making tools for the price of one. The cost is soon saved in time and labor. Stop using slow old-fashioned methods, and equip with a WODACK.

Manufactured by Wodack Electric Tool Corporation

43 S. JEFFERSON ST. CHICAGO, ILLS.



"WODACK" Combination Portable Electric Drill and Grinder Patented Nov. 1, 1921

CURRENT WELDING LITERATURE

CURRENT WELDING LITERATURE

METALLURGICAL ASPECTS OF WELDING, by Leslie H. Aitchison—Changes in the volume of an article being welded, due to the fact that no uniform temperature is set up throughout the part. Volume of material in some positions is different after it has cooled to what it was before it was heated for welding. This is an essential cause of warping and cracking. Steel which has been heated too high and too long cannot be recovered during welding any previous structure where the material basis is destroyed in the metal which forms the weld. A weld that is to be good must be closed tightly, and all cracks avoided.—Acetylene & Welding Journal, London, June.

THE OXY-ACETYLENE WELDING OF MILD STEEL, by D. Richardson—Methods used to determine the suitability of various material for welding purposes, and to develop a dependable test for judging the material from a welding point of view. Tests on mild steel plates to determine the comparative qualities of welds made with different kinds of filler material.—Acetylene & Welding Journal, London, June.

ELECTRIC WELDING IN RAILWAY SHOPS, by W. E. Symons—Early history of welding—Baldwin Locomotive Works pioneers in electric welding—Electric welding in locomotive shops—Patching flue sheets—Welding flues to flue sheets—Boiler repairs to locomotive zinc service—Training operators—Welding cast iron with the electric arc—Elements of doubt in riveted joints—Comparison of riveted seam and electric welded joint—Examples of defective workmanship in riveted seam method—Comparison of riveted seams and welded joints with tabulated data.—Railway & Locomotive Engineering, June.

AMMONIA PIPE LINES AND COILS, by C. Wilkie—The advantages of welded pipe lines—Fusion welding of steel pipe—Welding metal for fusion—Welding of steel pipe—Preparing pipe for welding—The efficiency of welded pipe joints—Relieving welding strains in pipe lines—Requirements of a first class pipe welded.—Acetylene Journal, July.

OXY-ACETYLENE WELDING OF OIL CARRYING PIPE LINES—Illustrating pipe line construction as carried on by the Prairie Pipe Line Co. in Oklahoma and Kansas.—Acetylene Journal, July.

THE OXY-ACETYLENE PROCESS IN 1922, by G. O. Carter—Review of recent developments in gas welding—Splendid results from our installation of all welded pipe lines—Examples of successful steam installation—Increased use of maintenance welding—Progress in extending the use of oxy-acetylene cutting.—Acetylene Journal, July.

WELDING OPPORTUNITIES IN AUSTRALASIA, by J. B. Green—Although there is little manufacturing done, there is considerable machinery needing repairs. For example, there is one railway, longer than any railway in the United States, and considerable mining. Automobiles are becoming more common. Practically all machinery is imported, and it is difficult to have repair parts on hand.—Acetylene Journal, July.

WELDING, CUTTING AND BRAZING PRACTICE, by David Baxter—Some ways by which a beginner in welding can distinguish between malleable iron and steel. How the torch can be used to advantage for brazing.—American Garage and Auto Dealer, June.

OXY-ACETYLENE PROCESS OF CUTTING METALS—Use of this method and some modern applications. Savings accomplished through elimination of special forgings and castings. Savings are particularly heavy on heavy material. When forgings are to be cut they are preheated to a dull red to eliminate strains and prevent checking. The use of mechanically operated oxy-acetylene cutting torches.—Machinery, July.

ELECTRIC AND MAGNETIC TESTS OF FUSION WELDS, by T. Spooner and J. F. Kinnard—Experimental methods which have been followed to develop tests for welded specimens which will not be destructive to the welded structures. The results, while not entirely convincing, indicate that tests of this sort may become commercially practical in the future.—Revue de La Soudure Autogene, Paris, May.

TOOL BOX PLATFORM ACCELERATES SPEED IN THERMIT RAIL WELDING

The tool box supplied by the Metal and Thermit Corporation, New York, for use in Thermit Rail Welding, has recently been equipped with a platform for ramming two-part molds which are applied to the rails preparatory to welding.

Tool Box Platform on Thermit Supply Wagon.

This innovation, shown with illustration, provides a suitable, ever-ready platform for this work which can be easily moved from place to place according to the progress of welding and enables molds to be quickly rammed near their point of application.

THERMIT USED TO HEAT SOLDERING IRON

Soldering irons are being heated in Europe by using a material used for incendiary purposes during the war. Thermit, is burned in a specially designed iron with body enlarged to take the thermit briquette. When the charge is ignited with a special match, it almost immediately becomes white hot and in a few seconds the iron has a temperature of 650 degrees F. which is maintained for eight or ten minutes. These new soldering irons are not intended to replace ordinary tools in the workshop, but are handy for repair and outdoor jobs. A domestic pressing iron is also made on the same principle, remaining hot for twenty minutes.

SALLWELD

ASBESTOS PAPER

SAL-MO PRODUCTS

Trade Mark

In rolls 36 inches wide weighing approximately 100 pounds each.

SLOWS UP COOLING PROCESS

No obnoxious or injurious fumes.

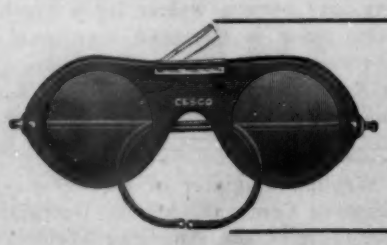
KEEPS DIRT OUT OF WELD.

Manufactured by

SALL MOUNTAIN COMPANY

140 So. Dearborn Street Chicago, Ill.

Eastern Office, Scranton, Pa.



No. 511

Welder's Spectacle

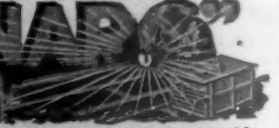
Manufactured by

Chicago Eye Shield Co.

2300 Warren Ave. Chicago

"ALTERNAD"

CUTTING and WELDING



Machine that can be taken to the work. We will do immovable jobs anywhere in the world. Do you know any? Write for our plan to show you by actual performance.

ELECTRIC ARC CUTTING & WELDING CO.

152-158 Jelliff Ave. Phones. Waverly 7802-7803 Newark, N. J.

ROL-MAN

WELDING RODS

ROL-MAN

For Gas Welding For Electric Welding

Manganese 12.00 - 15.00% Carbon 1.00 - 1.45%

ROL-MAN MANGANESE STEEL for MAXIMUM WEAR

For TRACK WORK, MILLS, MINES, FURNACES, SMELTERS, CRUSHING, SCREENING & DREDGING PLANTS

A True High Manganese and High Carbon Product in Rolled Rods and Drawn Wire
Presents Highest Abrasive Resistance and Maximum Wearing Qualities

Standard Sizes and Lengths Plain or Coated
MANGANESE STEEL FORGE CO.

Samples on Request
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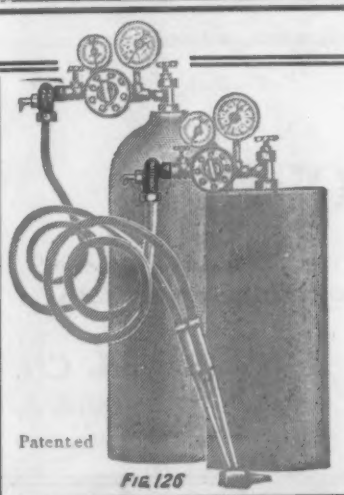

Patented

FIG. 126

MATTINGLY SAFETY VALVES

Prevent Personal Injuries, Fires and Waste of Gas — Safeguard the Welder — Ask for Literature

MATTINGLY AUTOMATIC VALVE CO.
714 North Second Street
St. Louis, Mo.

Dealers and Agents Wanted

WELDERS MOULDING COMPOUND

Every Oxy-Acetylene and Electric Arc welder has undoubtedly felt the demand for a fire resisting compound which could be moulded into any desired shape. When building up metal around holes in castings, and where welding is necessary through a machined part, such as a bearing, much time and machining can be saved in addition to making a neater appearing job by employing such a compound. Carbon blocks and rods have their field, but it is very limited. "Welder's Moulding Compound" can not only be used wherever carbon has been, but it has a much wider field. Moulds can be made for any missing lugs or parts and new ones cast that have all the appearance of having been machined. Aluminum parts may be "backed-up," preventing the collapse of the metal when heating.

For aligning broken sections, whether large or small, the usual shimming process may be forgotten and much time saved by using this compound as a cushion for the work. It can be used in hundreds of different ways, over and over again—it don't wear out. The wide-awake welder will appreciate its true worth.

5-LB. CARTON, WITH MANUAL OF INSTRUCTIONS - - - $2.50

Manufactured only by

UNITED STATES WELDING CO., Inc., Minneapolis, Minn., U. S. A.

MAKERS OF FAMOUS "U. S." WELDING AND CUTTING APPARATUS.

Superior Oxy-Acetylene Machine Company

Hamilton, Ohio, U. S. A.

Manufacturers of

WELDING AND CUTTING TORCHES, REGULATORS AND GAUGES,
SPECIAL BRASS PARTS, WELDING AND CUTTING OUTFITS,
CARBON BURNING AND LEAD BURNING OUTFITS, ELECTRIC DRILLS AND GRINDERS
CAST IRON—STEEL—BRASS AND ALUMINUM RODS, HOSE, FLUXES AND GOGGLES,

PEERLESS GENERATORS, as shown, are built in four sizes:

Carbide capacity	Cu. ft. of gas	Price
10-lb.	50 cu. ft.	$100.00
15-lb.	75 cu. ft.	110.00
20-lb.	100 cu. ft.	130.00
25-lb.	125 cu. ft.	150.00

(Allowance on acetylene tanks)

These Generators are PORTABLE, can be moved from one place to another, weighing about 135-lbs.

AUTOMATIC, equipped with the CELEBRATED SUPERIOR FEED.

GENERATES gas for about $1.20 per 100-cu. ft.

Batteries—Lead Molds—Post Builders—Lead Pots—Plate Burning Racks—Stencil Letters and Figures—Trucks—Preheaters.

Write for complete catalog.

We repair all makes of Torches, Regulators and Gauges.

Welding Carbon Products

Columbia Round Welding Carbons
Columbia Welding Carbon Plates
Columbia Welding Carbon Paste
Columbia Welding Carbon Flour

Our welding carbon products are designed especially for welding operations

National Carbon Company, Inc.
Cleveland, Ohio San Francisco, Cal.

CAST IRON RODS MADE FROM PIG IRON
(NO SCRAP USED)

Approximating
3.00%—in Silicon (Result: A soft weld)
.60%—in Phosphorus (Result: Fluidity)
.02%—in Sulphur (Result: A clean weld)

Our Rods the Best by Test. Also Rods, Wires and Fluxes for Welding All Other Metals

Prices on Application

Bierman-Everett Foundry Co.,
133-153 So. 20th St., Irvington, N. J.

OXYGEN
FOR CUTTING, WELDING, ETC.

Quick shipment and low prices on oxygen, hydrogen, cylinders, valves, Rego welding and cutting torches, regulators, welding wire, cast iron and aluminum rods, fluxes, plain and armored rubber hose, asbestos pads and paper, goggles, etc. All equipment fully guaranteed.

We are American pioneer manufacturers of oxygen. Write for catalog and prices.

International Oxygen Company
Main Offices: NEWARK, N. J.
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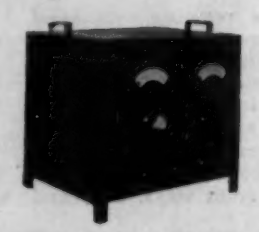
Specify— "MOREY"

A Moisture Proof Aluminum Flux
Stable, Economical, Marvelous

MOREY FLUX & CHEMICAL CO.
Parkesburg, Penna. U. S. A.
Est. 1912 Inc. 1915

QUASI-ARC SYSTEM



We Manufacture:
A. C. & D. C. Welding Sets
Also Weldtrodes for
Mild Steel
High Carbon
Manganese
Cast Iron

L. W. 110 V. WELDER Gives Machinable Weld

QUASI-ARC WELDTRODE CO., INC.
Peekskill, New York

TYPE M6
½ H. P. MOTOR

Strand
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GRIND Those Welds With
STRAND
Flexible Shaft Grinders
Thousands in Use

N. A. Strand Co.
CHICAGO
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W WESTINGHOUSE ELECTRIC

Westinghouse
manufactures complete arc welding equipment for all welding and cutting purposes. Write for Leaflet 1826-B which describes this equipment in detail.

Westinghouse Electric & Manufacturing Co.
East Pittsburgh, Pa.

Thermalene Gas *for Cutting & Welding*

©1922 BY THERMALENE GAS CORPORATION

IMPERIAL WELDING AND CUTTING EQUIPMENT
OXY-ACETYLENE PROCESS

A new mixing principle, a regulator that accurately controls gases, the greatest working range ever covered by ONE torch—are exclusive IMPERIAL features. Write for catalog.
Imperial Brass Mfg. Co., 517 S. Racine Ave., Chicago

DAVIS BOURNONVILLE

DAVIS-BOURNONVILLE COMPANY
was merged with
AIR REDUCTION SALES COMPANY
on March 17, 1922

The Oxyacetylene Welding and Cutting products formerly manufactured by Davis-Bournonville Co. are now made and sold by Air Reduction Sales Co. under the trade name of "Airco-Davis-Bournonville" or "Airco-D-B."

(See advertisement of Air Reduction Sales Co.)

AIRCO

Carbic

"Carbicutting"

CARBIC CAKES

In the use of Carbic Cakes is hidden the secret of the success of the Carbic System. These solid, clean briquets that slide quickly and easily into the generator, permit an ease of handling, a convenience and a safety not otherwise obtainable.

For cutting, as for welding, the Carbic System of generating acetylene from Carbic Cakes contains unrivaled advantages.

The simplicity of generation, the cool, clean gas, the safety, the portability and the economy—all these, combined with many other features, give the Carbic System its well earned popularity.

There are hundreds of Carbic users in every section of the country. In all seasons of the year and under widely varying climatic conditions, Carbic is serving even the most exacting requirements of all classes of trade, from the small garage up to the largest steel plant.

Consider the Carbic System for your work. Write us today.

The Carbic System is complete, including generators, torches, regulators, hose and all other necessary apparatus and accessories.

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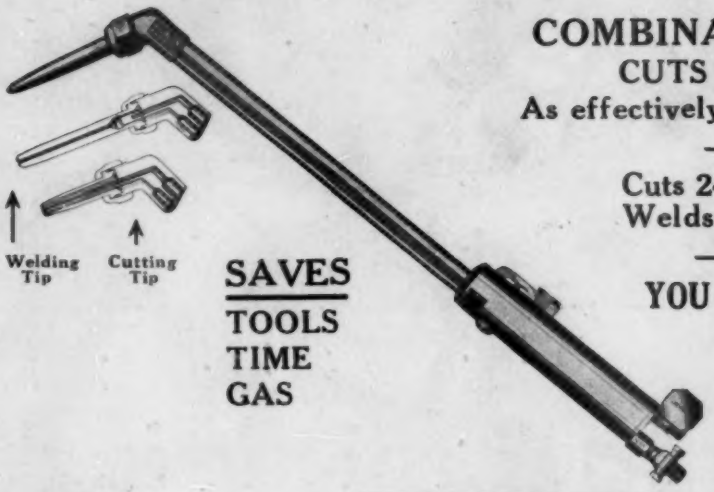
Warehouses and representatives in other principal cities.

We are also the exclusive manufacturers of Carbic Portable Lights.

MILBURN



COMBINATION TORCH
CUTS and WELDS
As effectively as separate torches

Cuts 24 inches thick
Welds heaviest jobs

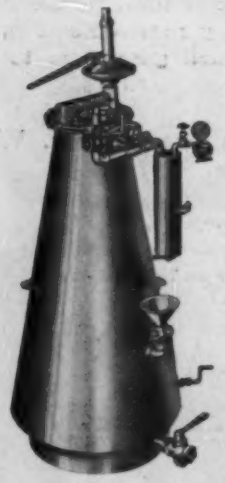
SAVES
TOOLS
TIME
GAS

YOU MERELY CHANGE THE TIP

REGULATOR
OVERCOMES FAULTY PRESSURE
Facilitates Welding and Cutting

Built of Forged Bronze—Tensile Strength over 50,000 Pounds
The same Regulator for Welding and Cutting — and all Gases

Seats *with* instead of *against* pressure



30 lbs. CARBIDE PORTABLE GENERATOR
Automatically makes your acetylene gas at approximately 1c a cubic foot

Equivalent to 150 cubic foot cylinder of gas

Uses Commercial Carbide—procurable everywhere

Has no clock motor or gears

Steel body welded throughout
Weighs 200 pounds

THE ALEXANDER MILBURN COMPANY
BALTIMORE, MD.